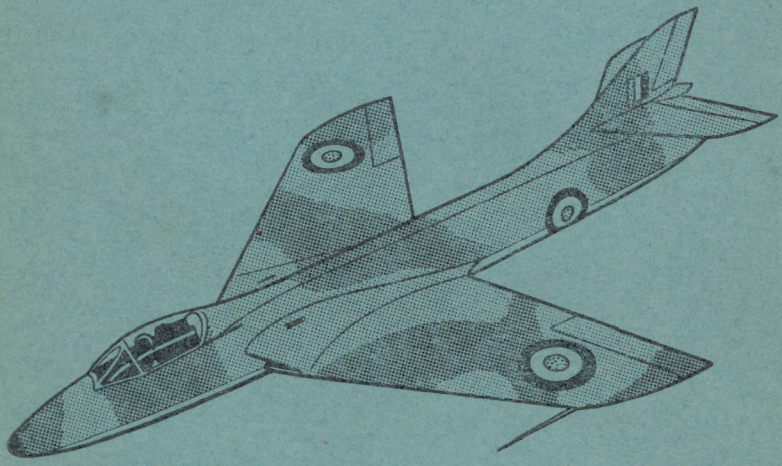
RESTRICTED

2nd Edition
June, 1956

A.P.4347E — P.N.

PILOT'S NOTES

HUNTER F.5



Prepared by Direction
of the
Minister of Supply

J. R. C. Helmore

Promulgated by Order
of the
Air Council

L. J. Dean.

RESTRICTED

AIR MINISTRY
July, 1958

Amendment List No. 3
to AP.4347E—P.N.
Pilot's Notes
(2nd Edition)

HUNTER F.5

NOTE.—1. Incorporation of this Amendment List must be certified by inserting the date of incorporation and initials in the spaces provided on page 1 of the Notes.

2. When a manuscript amendment is made, the adjacent margin should be endorsed "A.L.3".

3. This Amendment List also covers the following Special Flying Instructions:—

S.F.I.'s Hunter/47, 48

4. When the Amendment List is fully incorporated, *affix* this sheet to the inside front cover of the Notes.

PAGE	PARA.	AMENDMENT
14	5 (b) (i)	*Amend* by gummed slip herewith.
49	—	*Amend* by gummed page herewith.
50	55 (f) NOTE	*Amend* by gummed slip herewith.
64	65 (a)	*Amend* last four lines by gummed slip herewith.
65	65 (e)–(h)	*Amend* by gummed slip herewith.
75	75 (a)	*Amend* by gummed slip herewith.
76–78	—	*Amend* by three gummed pages herewith.
47	52–53	*Amend* by gummed slip herewith.
49	55 (a) (ii), (b)	*Amend* by gummed slip herewith.
49	55 (d)	*Add* "or bombs" after "with drop tanks".
56	59	*Amend* by gummed slip herewith.
62	62 (contd.) line 1	*Amend* 3,000 to read 2,850.
77	76 (b), line 5	*Amend* 3,000 to read 2,850.
82	84	*Amend* by gummed slip herewith.
84	—	*Amend* by gummed page herewith.
85	88 (a) (b)	*Amend* by gummed slip herewith.
86	89 (a) (i) line 2	*Amend* 3,000 to read 2,850.
92	92 (a)	*Delete* these four lines.
93	92 (a) contd.	*Amend* by gummed slip herewith.
100	99	*Amend* by gummed slip herewith.
Outside back cover	Final checks for landing	"Brakes." *Amend* 3,000 to read 2,850.

NOTES TO USERS

These Notes are complementary to A.P.129 (6th Edition), Flying, and assume a thorough knowledge of the chapters which are relevant to the operation of this type of aircraft. (See A.M.O. A.293/55).

Additional copies may be obtained by the station publications officer by application on R.A.F. Form 294A in quadruplicate to Command Headquarters for onward transmission to A.P.F.S. (see A.P.113A). The number of this publication must be quoted in full—A.P.4347E—P.N. (2nd Edition).

Comments and suggestions should be forwarded to Officer Commanding, Handling Squadron, R.A.F., Boscombe Down, Wilts.

AMENDMENTS

Amendment lists will be issued as necessary and will be gummed for affixing to the inside front cover of these notes. Each amendment list will, where applicable, be accompanied by gummed slips for sticking in the appropriate places in the text.

Incorporation of an amendment list must be certified by inserting date of incorporation and initials below.

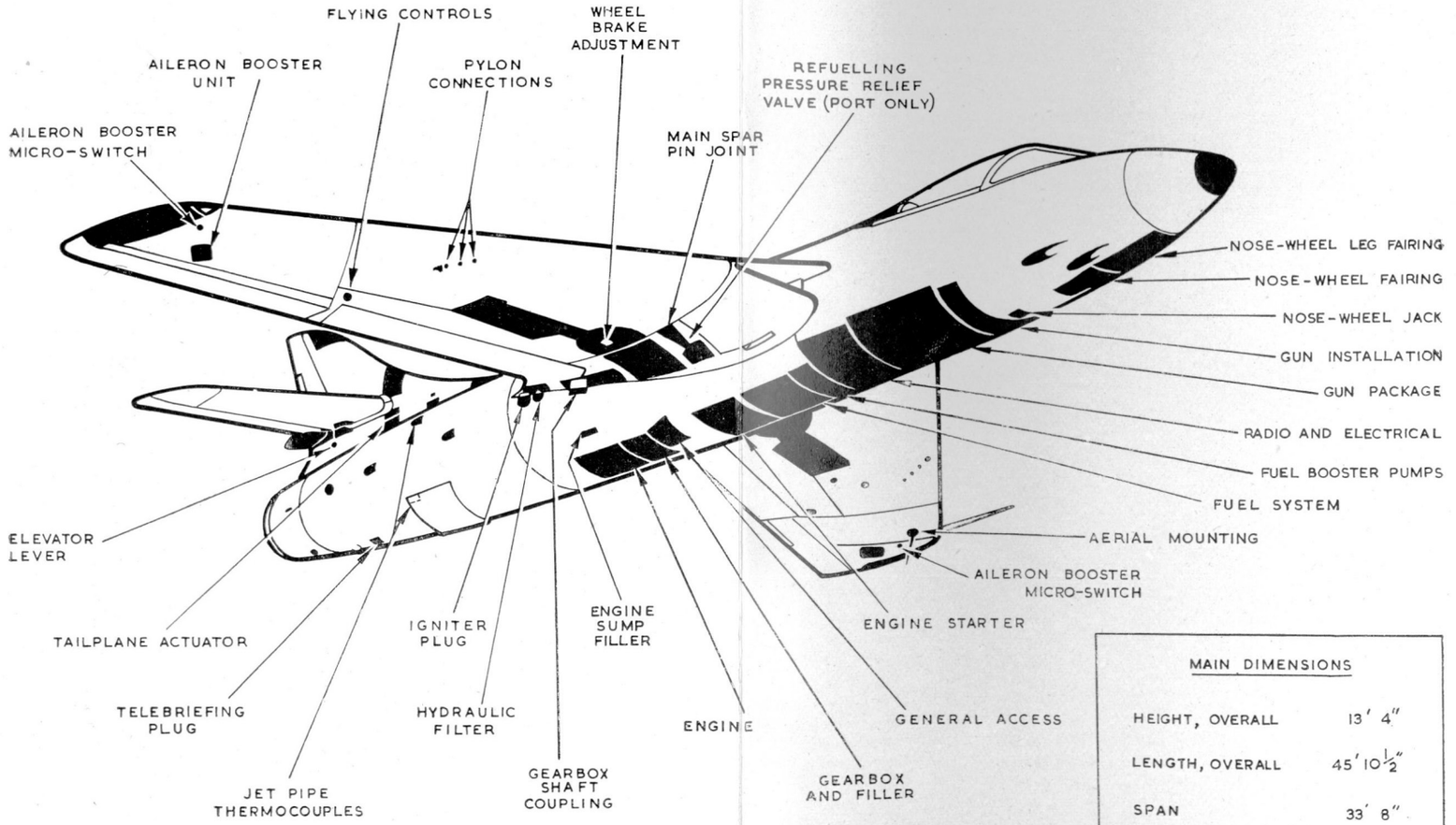
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3	[signature]	3.12.58	6		

HUNTER F.5

LIST OF ASSOCIATED AIR PUBLICATIONS AND AIR DIAGRAMS

	A.P.
Aden 30 mm. guns	1641S
Cine cameras and accessories	1355
Ejection seats, R.A.F., aircraft, Mk. 2 series	4288B
Electrical equipment manuals	1095 series
	4343 series
Fuel system components—Lucas	4282A
Gyro gunsights	1275E
Hydraulic equipment, Dowty	1803D
Hydraulic servicing trolley	2306B
Instrument manuals	1275 series
Powered flying control units—Fairey ...	4601A
Pressure cabin testing, servicing trolley ...	2306G
Pressurizing and air conditioning equipment	4340
Pressure fuelling equipments	4511
Rotol accessory gearboxes and drives ...	2240A
Sapphire Mk. 10100 series ECU	4355A
Starting systems for aero engines	1181 series
Undercarriage equipment, Dowty	1803E
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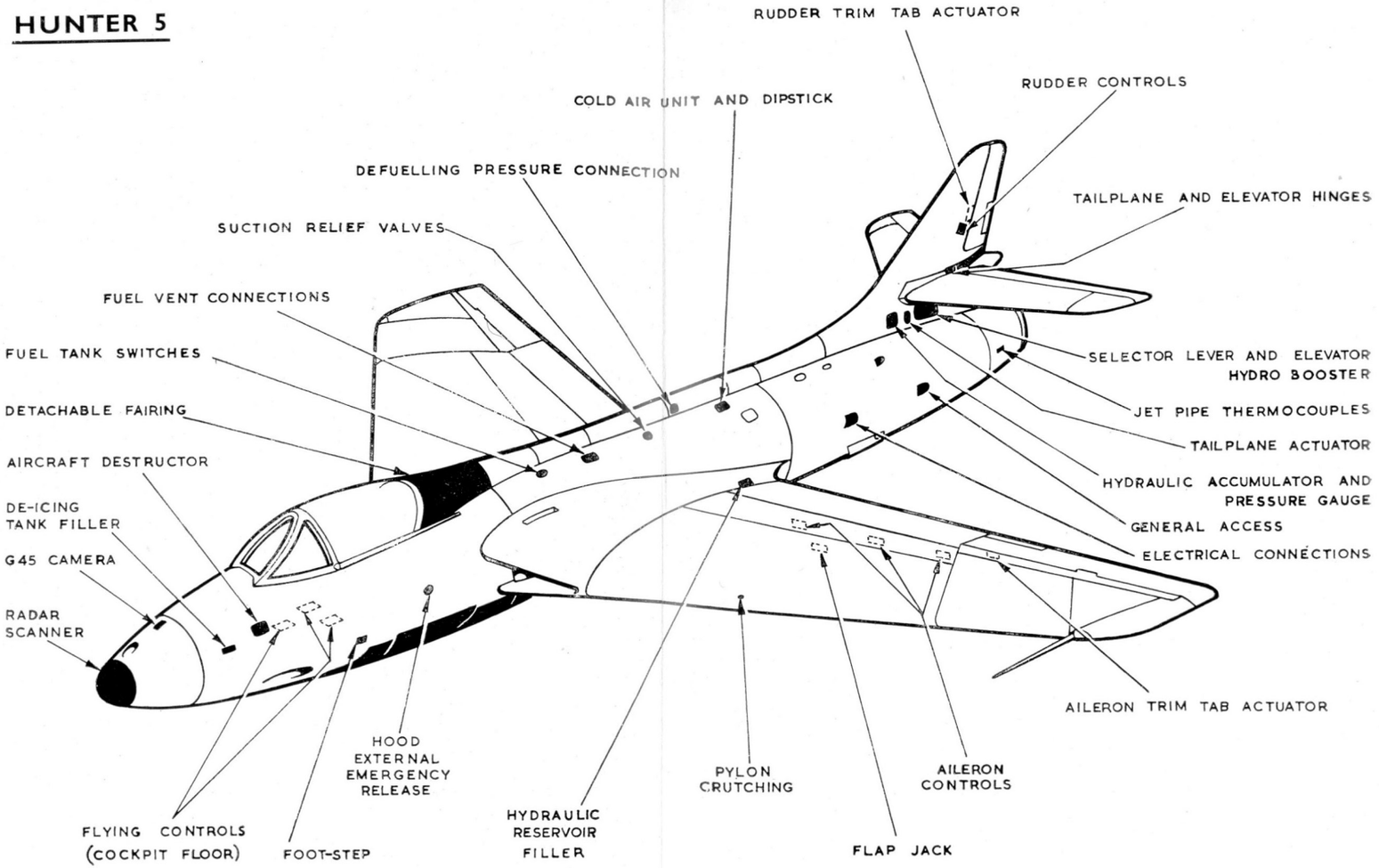
HUNTER 5



ACCESS PANELS—UNDER SURFACE

MAIN DIMENSIONS	
HEIGHT, OVERALL	13′ 4″
LENGTH, OVERALL	45′ 10½″
SPAN	33′ 8″

HUNTER 5



ACCESS PANELS — UPPER SURFACE

AIR MINISTRY
June, 1956

A.P.4347E—P.N.
Pilot's Notes
2nd Edition

HUNTER F.5

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PART I

DESCRIPTIVE

NOTE.—Throughout this publication the following conventions apply:—

(a) Words in capital letters indicate the actual markings on the controls concerned.

(b) The numbers quoted in brackets after items in the text refer to the illustrations in Part VI.

(c) Unless otherwise stated, all airspeeds and Mach numbers quoted are " Indicated."

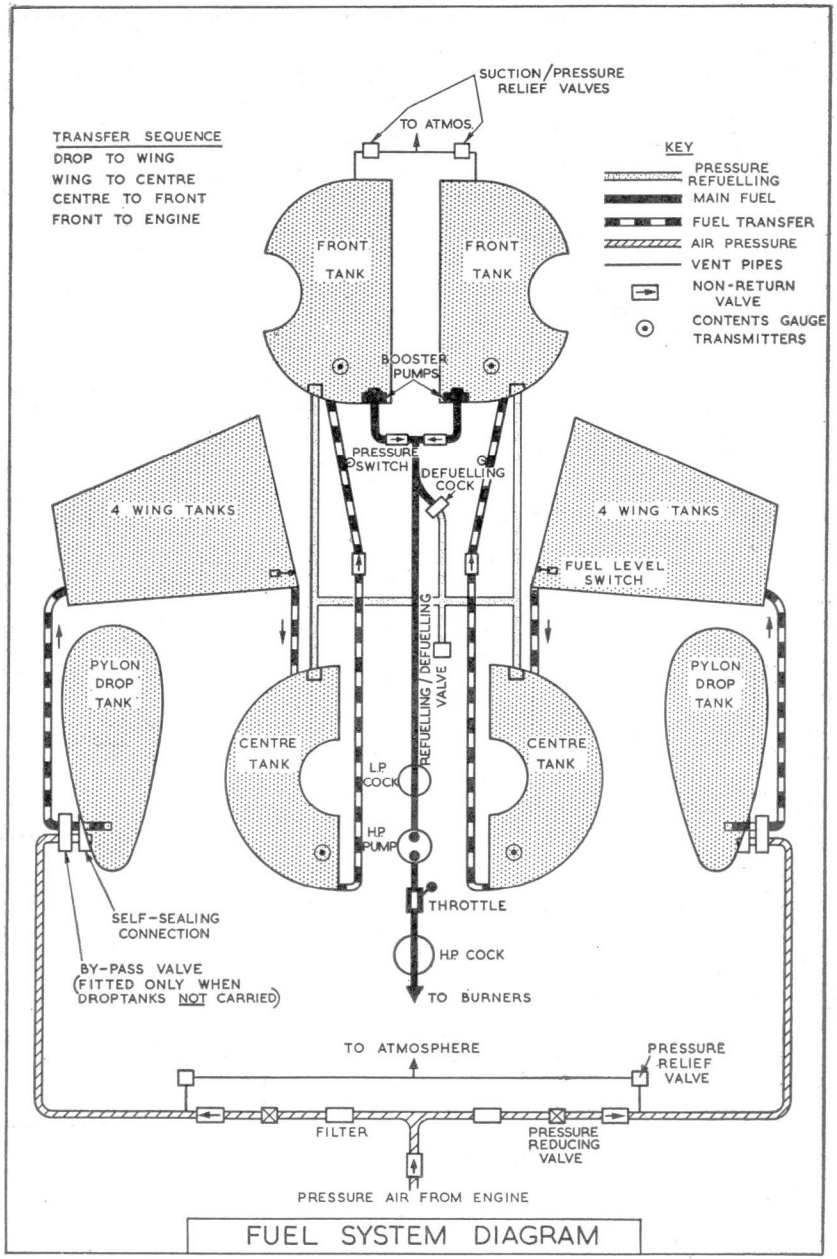
(d) All fuel poundage figures are calculated at 7.7 lb./gall. (Normal AVTAG).

1. Introduction

(a) The Hunter F.5 is a single-seat mid-wing fighter aircraft, with swept-back wings and a swept-back variable-incidence tailplane. Full-power ailerons and power-assisted elevators are fitted, both with manual reversion. When Mod. 365 is incorporated a full-power elevator replaces the power-assisted elevator. In such aircraft audio warning of hydraulic failure is provided by Mod. 327. The cockpit is pressurized and equipped with a Mk. 2H ejection seat.

(b) The power unit is a Sapphire Mk. 101, developing 8,000 lb. static thrust at sea level.

(c) Four Aden 30-mm. guns are installed in a detachable armament package in the fuselage undersurface.



FUEL SYSTEM DIAGRAM

FUEL AND OIL SYSTEMS

2. Fuel tanks and gauges

(a) Fuel is carried in four flexible bag-type tanks, in the centre fuselage, and in four interconnected tanks in the forward edge of each wing. Provision is made for carrying two 100-gallon pylon drop tanks.

(b) Each front tank contains an electrically-driven booster-pump fitted in a negative G fuel trap, the total contents of both permitting at least 15 seconds inverted flight.

(c) The tank capacities are:—

	Gallons	Weight (lb.) at 7.7 lb./gall.
Front tanks (2 × 101) ...	202	1,555
Centre tanks (2 × 23) ...	46	352
Wing tanks (2 × 70) ...	140	1,078
Total, internal ...	388	2,985
Pylon drop tanks (2 × 100)	200	1,540
Total, all tanks ...	588	4,525

(d) Two electrical contents gauges (73) on the starboard shelf indicate, in pounds, only the contents of the fuselage PORT TANKS and fuselage STBD. TANKS. There are no gauges for the wing tanks (on early aircraft) or for the drop tanks.* A CONTENTS CHECK switch (72), aft of the gauges, has two positions, ENGINE ON and ENGINE OFF. It is spring-loaded to the ENGINE ON position and is for use when it is required to check the contents with the engine stopped.

*Later aircraft will be fitted with gauges indicating the total contents of both wing and fuselage tanks.

3. Fuel transfer system

(a) Fuel from the drop and ~~rear~~ wing tanks is fed, by air pressure from the engine, to the centre tanks and then to the front tanks.

(b) The fuel transfer and the air pressure pipes are joined to each drop tank by means of a self-sealing connection, which automatically interconnects the air and fuel pipes when the drop tanks are jettisoned. When drop tanks are not carried, a bypass valve must be fitted to interconnect the two pipes.

(c) Two low level magnetic indicators (75), one for each set of wing tanks, show white when transfer from the wing (and drop) tanks is complete. The gauge readings should then begin to show a steady drop.

(d) Should the transfer system fail completely, no fuel will transfer from the wing and centre tanks. This is indicated by two indicators (71), one on each side of the contents gauges switch (72), showing white. At the same time the contents gauge transmitters in the centre tanks will become inoperative and the gauges will then only indicate the contents of the front tanks, i.e., the amount of fuel available to the engine. If only one side of the transfer system fails, the appropriate TRANSFER FAILURE indicator will come on and the associated gauge will indicate the available contents.

4. Main fuel feed system

The two booster-pumps deliver fuel from the front tank to a common pipe line, through the L.P. cock and thence to the engine-driven H.P. pumps. From the engine-driven H.P. pumps fuel is fed through the H.P. cock to the burners.

5. Booster-pumps control

NOTE.—Fuel balancing does not commence until the fuel gauge readings begin to fall from full indication, *i.e.*, on early aircraft when the wing and drop tanks are empty or, on later aircraft, when the drop tanks are empty.

(a) *Booster-pumps control (unmodified aircraft)*

(i) The contents of the port and starboard tanks which are gauged (*i.e.*, fuselage tanks early aircraft—wing and fuselage tanks later aircraft) are kept in balance by adjusting the rate of delivery from the front tanks booster-pumps. The pumps are electrically monitored by the fuel contents gauges so that should one side of the system tend to empty more quickly than the other, the delivery of the pump on that side is reduced until the levels are again approximately correct. (See para. 56 (c) (ii) and (iii).)

(ii) The fuel booster-pumps are controlled by two AUTO–OFF–MANL switches (78). The conditions obtained with the switches in various positions and both fuel gauges indicating less than full contents, are:—

Both switches at AUTO	Both pumps run under balance control conditions.
One switch at OFF One switch at AUTO or MANL	Pump controlled by switch at AUTO or MANL will run at full speed without balance control.
One switch at MANL One switch at AUTO or Both switches at MANL	Both pumps run at full speed without balance control.
Both switches OFF	Gravity feed only.

Only when *both* switches are at AUTO and when the ungauged tanks are *empty* will balance control conditions obtain. AUTO should be selected at all times except when either abnormal conditions obtain, or when fuel from ungauged tanks is being transferred. (See para. 56 (c) (ii) and (iii).)

(iii) Two circuit-breakers (84), one for each booster-pump, an ammeter socket (83) and a test switch (87) are on the starboard shelf.

A.L.3
Page 14
Para. 5(b)
(i)

(b) *Fuel proportioner (later aircraft)*

(i) On later aircraft the fuel balancing equipment is replaced with a fuel proportioner. The booster-pumps are then controlled by two ON/OFF switches on the starboard shelf.

(ii) Fuel from each booster-pump is fed separately to the flow proportioner (a pair of gauged vane-type pumps on a common drive). Each proportioner pump delivers an equal amount of fuel to a single exit port;

thence it is fed through the L.P. cock to the engine. Unequal feeding should only occur if one booster-pump delivery pressure differs from the other by more than 2 lb./sq. in. If the proportioner fails, fuel bypasses it via spring-loaded non-return valves.

(iii) Management of the fuel system is similar to that given in para. 56. For AUTO or MANL, read ON.

(c) *Booster-pump failures*

(i) Should the contents gauges show more than 100 lb. difference in contents with both pumps at AUTO then either balance control or booster-pump failure has occurred.

(ii) Failure of a pump in AUTO will leave balance control on the remaining pump and since the fuel from the side on which failure has occurred will be fed by gravity only, the serviceable pump will go to minimum delivery. To check if a pump has failed, switch OFF the pump on the low contents side when the low pressure warning indicator should show white. If no such indication occurs then balance failure as opposed to pump failure has occurred and balance can only be obtained by controlling the pumps between the MANL and OFF positions.

NOTE.—Later aircraft will be fitted with two booster-pump failure red warning lights, one for each pump. In this case, the low pressure indicator will not show white if the test above is carried out.

(iii) If gauge failure occurs one or both gauges will read zero and it will be impossible to tell whether balance control is in operation or not.

6. H.P. pump

(a) A servo control system limits the pump output and a governor limits over-speeding of the engine.

(b) Control of the fuel flow is effected by:—

(i) The throttle, to meter fuel to the burners.

(ii) A barometric flow control (BFC), to vary the pump output in relation to intake pressure.

(iii) An air/fuel ratio control (AFC) to prevent an excess supply of fuel to the engine during periods of engine acceleration.

Both BFC and AFC are connected to the servo control system.

7. **H.P. fuel cock**

The H.P. fuel cock control (32) is mounted in a quadrant on the cockpit port shelf, and is moved forward from OFF to ON. A safety gate is provided to ensure that the H.P. cock cannot be moved unless it is first pressed downwards.

8. **L.P. fuel cock**

The L.P. fuel cock control (13) is adjacent to the H.P. cock control and also moves forward from OFF to ON.

A.L.2
Para. 9
Page 16

9. **Oil system**

Oil is carried in the engine sump, the capacity of which is 9 pints, with an additional 1½ pints in the engine. One pressure and one scavenge pump maintain a continuous circulation through a cooler and filter to the engine bearings and gears.

ENGINE CONTROLS

10. **Engine starting system**

(a) Starting is by means of a twin-breech cartridge starter which accelerates the engine until it becomes self-sustaining.

(b) Fuel for starting is delivered through a solenoid valve to six starting atomizers, where it is ignited by two high energy igniter plugs. Both the solenoid valve and the igniter plugs are energized when the starter button is pressed. During initial starting the throttle must be in the half-open position.

(c) The main control switches are:—

(i) The *battery master switch* (67).

(ii) The *ignition switch* (66) which controls the current to the igniter plugs. It should normally be locked in the ON position.

(iii) *The starter master switch* (63) *and circuit-breaker* (85). These complete the circuit through the starter button, ignition switch and relight switch. When the relight button is pressed, the starter button is isolated. The master switch also controls the electrical supply to the engine instruments, and completes the circuits to No. 1 inverter and the booster-pumps. The switch should be ON and the circuit-breaker in at all times when the engine is running.

(iv) The *starter pushbutton* (62), which initiates the starting sequence.

(d) When the battery master, engine master and ignition switches are all ON and the starter button is pressed, a cartridge is indexed and fired. The cartridge fires over a period of 4 seconds and causes the compressor to turn. At the same time full current is fed to the high energy igniter plugs which ignite the fuel spray. After 5 seconds a time switch de-energizes the ignition relay, closing the starting fuel solenoid valve and cutting out the igniters. After 11 seconds the engine should have accelerated to 3,000 r.p.m. Twenty-nine seconds after pressing the starter button the automatic time switch de-energizes the hold-in solenoid of the button allowing it to become operative once more.

11. **Restarting in flight system**

A relight button (33) is incorporated in the top of the H.P. cock control lever. It completes the circuit to the igniter plugs when relighting is required in flight.

12. **Throttle control**

The throttle control lever moves in a quadrant on the port shelf, the handle of the lever incorporating a twist-grip for

GGS manual ranging, a press-to-transmit pushbutton (19) and the airbrake control (20). A throttle damper (18) is aft of the lever.

13. Engine instruments

The engine instruments comprise a jet pipe temperature gauge, an oil pressure gauge and an r.p.m. indicator.

14. Engine fire-extinguisher equipment

(a) Two fire-extinguisher bottles, stowed between the air intakes just forward of the engine are connected to the engine extinguisher inlet connection. Operation of the system is either by:—

(i) A manually-operated pushbutton (52) in the cockpit, on the starboard coaming, or

(ii) An automatically-operated inertia switch which operates if a crash landing occurs. When the inertia switch operates, the batteries are automatically isolated irrespective of the position of the battery master switch.

(b) Twelve resetting flame detector switches are situated around the engine and forward part of the jet pipe. Operation of any of the switches causes the ENGINE FIRE warning light (52) incorporated in the pushbutton to come on, provided electrical power is available. When the button is pressed the extinguishers discharge their contents through two spray rings, the forward of which encircles the engine compressor and the rear the turbine nozzle box. If the fire is extinguished, the light goes out as the flame switches cool.

(c) The warning light may be tested by pulling out the extinguisher pushbutton. Modified aircraft are provided with a test switch on the starboard coaming. On such aircraft the light should be tested by use of the switch.

(d) When the battery master switch is OFF the fire-extinguishers can be operated only by the inertia switch. The battery master switch must be ON to test the warning light or to operate the system by pushbutton.

MAIN SERVICES

15. Hydraulic system

(a) An engine-driven hydraulic pump maintains a live-line pressure of 3,000 ± 150 lb./sq. in. for the normal operation of the:—

Undercarriage and doors

Flaps

Wheel brakes

Aileron and elevator hydroboosters

Airbrake

The main pressure is indicated by the central needle of the triple pressure gauge (35) at the forward end of the port shelf.

(b) Five hydraulic accumulators are fitted in the circuit to provide a reserve of power in an emergency. The hydraulic side of the accumulators is connected to the wheel brakes (two), aileron hydroboosters (two), and elevator hydrobooster (one) respectively.

A.L.2 Para. 15 (c) Page 19

(c) The pressure available in the wheel brakes accumulators is shown on a gauge (9) on the port shelf. The accumulators are charged with air to a pressure of 750 lb./sq. in. via a connection in the nosewheel bay. The aileron accumulators are charged to 1,575 lb./sq. in. (900 lb./sq. in. when Mod. 690 is embodied) via a connection in the starboard wheel bay and the elevator accumulator is charged to 1,575 lb./sq. in. via a panel in the port side of the fin. The pressure in the elevator accumulator is shown on a gauge visible through a transparent window on the fin; the pressure in the two aileron accumulators is shown on a gauge adjacent to the charging point.

(d) Indication that failure of the live-line system has occurred is given by the main needle of the triple pressure gauge and, when pressure has fallen to 600 lb./sq. in. the illumination of a red warning light on the port side of the instrument panel. When Mod. 327 is incorporated an audio warning also gives warning of hydraulic failure. This is the same audio warning, previously used for cockpit pressure failure. When the audio warning cut-off switch (59) is operated the warning is discontinued.

(e) Two high pressure air bottles, which are charged to 1,800-2,000 lb./sq. in., are provided for the emergency lowering of undercarriage and flaps respectively. Air pressure gauges (9) (10) for the bottles are mounted on the port shelf.

(f) A hydraulic handpump, for ground test purposes, is fitted in the engine bay.

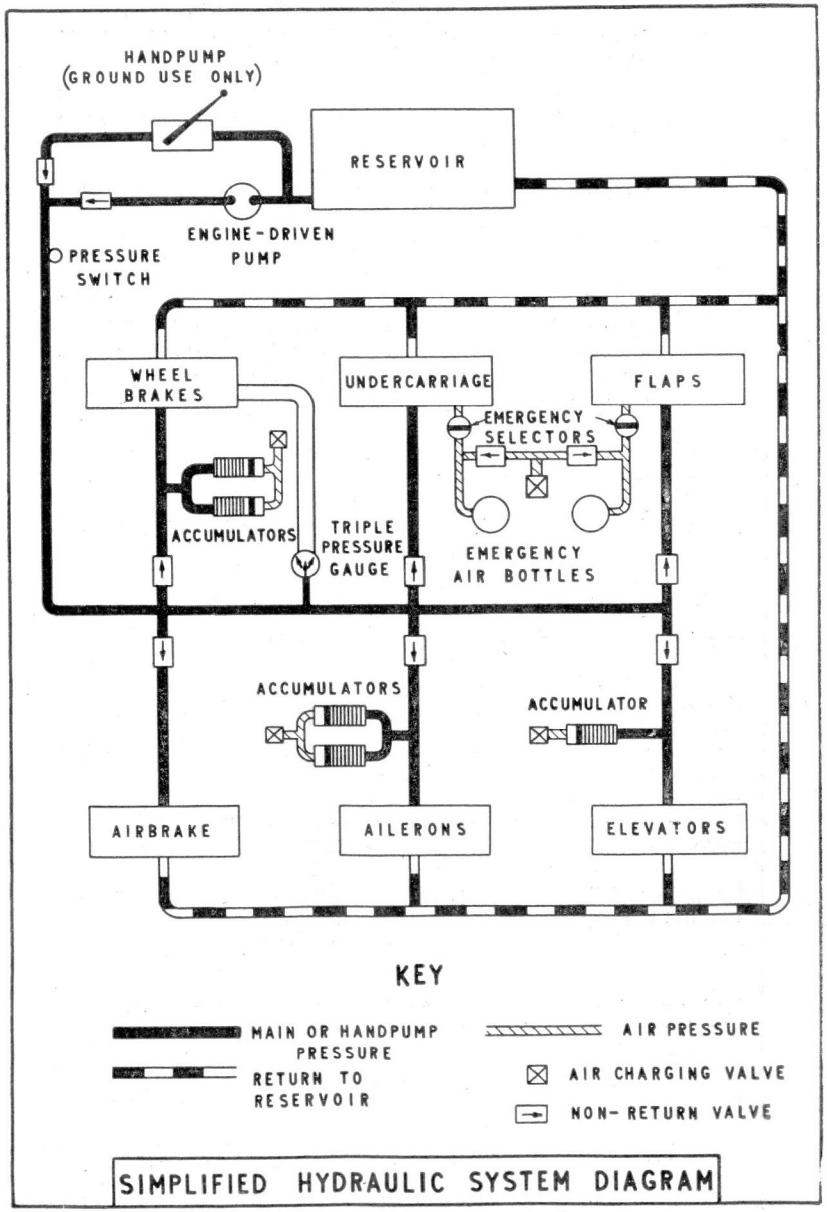
16. Electrical system (24 volt)

A.L.2 Para. 16 (a) (i) Page 20

(a) *D.C. supply*

(i) Two 6,000-watt d.c. engine-driven generators supply the whole of the electrical system and charge two 12-volt aircraft batteries connected in series. When Mod. 386 is embodied two 24-volt batteries, connected in parallel, are fitted which double the available reserve if generator failure occurs. Two generator failure warning lights (61), situated below the centre of the instrument panel, come on only when their associated generator is not supplying power.

NOTE.—Minimum engine r.p.m. to keep the batteries fully charged are 3,700 (4,000 if one generator has failed). It must not be assumed that the generators are charging adequately if neither warning lamp is lit. The batteries can be taking an appreciable load with both lights out at low r.p.m.



SIMPLIFIED HYDRAULIC SYSTEM DIAGRAM

(ii) Control of the batteries is effected by a BATTERY MASTER switch (67) below the centre of the instrument panel. When set to OFF the switch isolates all electrical services from the batteries except the engine fire-extinguisher inertia switch.

(iii) An external ground supply socket is accessible via the radio bay door and is for use when a ground battery is necessary for servicing purposes.

(iv) The following table lists the various electrical warning lights and indicators in the cockpit. Failure in any circuit incorporating a magnetic indicator (with the exception of radar ranging) is shown by the indicator showing white.

Service	Indication	Function
Fire warning	1 red light (52)	Gives warning when temperature in engine bay exceeds 300 ± 30°C.
Fuel pressure warning	1 white magnetic indicator	Indicates fuel pressure low at engine inlet
Fuel transfer warning	2 white magnetic indicators (71)	Indicate failure of transfer system
Wing tank transfer	2 white magnetic indicators (75)	Indicate transfer from wing tanks complete
Booster pump warning	2 red lights (when fitted)	Indicate failure of associated booster pumps
Generator failure warning	2 red lights (61)	Indicate generator failure due to (1) Cut-out not closed (2) Fault in circuit
Radar ranging warning	1 white magnetic indicator (above 27)	Indicates radar ranging in use
Radar ranging operation	1 blue light (49)	Indicates radar ranging locked on target
Hydraulic failure warning	1 red light	Indicates hydraulic pressure below 600 lb./sq. in.

Service	Indication	Function
Undercarriage position	3 red or green lights (37)	Indicate position of each U/C unit separately No light—unit locked up Red light—unit between locks Green light—unit locked down.
Undercarriage warning	1 red light (36)	Indicates when throttle closed and U/C ~~locked up~~ NOT LOCKED UP A.L.1.
Powered controls	2 white magnetic indicators (42)	Indicate separately disengagement of aileron or elevator hydroboosters, or fault in electrical circuit
Airbrake	1 white magnetic indicator (33)	Indicates airbrakes not fully retracted
Cockpit pressure warning	1 red light (56)	Indicates drop of ½ lb./sq. in. in cabin pressure differential.
Telebriefing	1 amber light (23)	Indicates telebriefing in use

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(v) *Emergency battery*
An emergency battery is provided to supply the emergency lamps, the Manual emergency selector circuit (Mod. 502) and, when Mod. 488 is embodied, the turn and slip indicator. If fully charged the battery will provide between 7 and 20 hours' continuous use, depending on the load imposed on it.

(b) *A.C. Supply*

(i) A.C. for the Mk. 4F compass, artificial horizon and oil pressure gauge is supplied by No. 1 Type 100A inverter, with No. 2 Type 100A inverter acting as a standby. The engine starter master switch normally controls the circuit to the inverters but No. 2 inverter does not come into circuit until micro-switches, attached to the undercarriage, are operated when the weight is taken from the undercarriage as the aircraft becomes airborne. If No. 1 inverter fails, automatic changeover to No. 2 inverter occurs, which causes a magnetic indicator on top of the A.C. junction box to show white.

(ii) When No. 2 inverter is in circuit it also acts as a feed to the radar ranging. When the latter is switched on, No. 2 inverter operates a torque switch to bring into operation a Type 200 inverter which supplies the radar ranging. If auto-changeover occurs, the torque switch trips and the radar ranging is inoperative.

(iii) A.C. for gun firing is supplied by a Type 300 inverter which is brought into operation when the gun firing safety flap is raised, provided that the gun firing circuit is in operation (see para. 52(a)).

(iv) Located on top of the A.C. junction box at the aft end of the port shelf, in addition to the changeover indicator, are two circuit breakers, for the Type 100A inverters, and

a TEST/NORMAL switch (for servicing purposes). The latter switch should be set to NORMAL (inboard) for flight conditions. In flight none of these is visible or accessible.

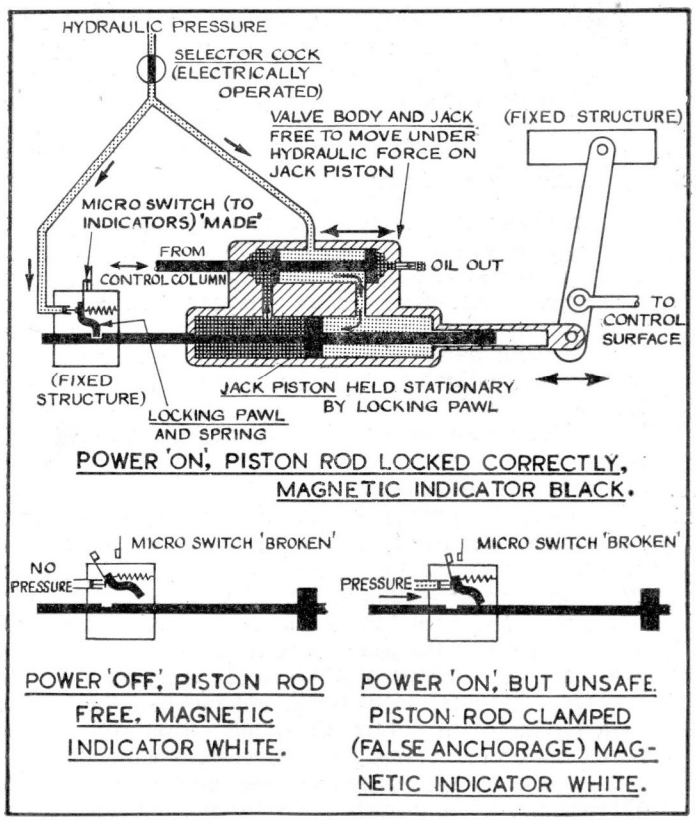
(iv) To test the standby inverter, first check that the engine master switch is OFF and then set the battery master switch ON, the inverter test switch to NORMAL (inboard) the inverter circuit-breakers in and then move the RADAR TEST switch (8) to TEST. The inverter can then be heard to operate and the artificial horizon can be seen to erect. When the test is complete return the radar test switch to OFF.

POWERED FLYING CONTROLS AND TRIMMERS

17. Flying controls operation

(a) *In Power*

The ailerons and elevator are power-operated, the power being supplied by hydraulic oil under pressure from the aircraft hydraulic system. A hydrobooster consisting of a valve and jack body and a piston rod is fitted close to each control surface. The control column is connected direct to the valve control rod so that depending on the direction of movement of the control column, the valve opens to admit pressure oil to one side of the jack piston and at the same time the other side is opened to return. The piston rod is anchored to the aircraft structure (ailerons and full power elevator) or to the control circuit (power-assisted elevator) by means of a spring-loaded hydraulically-operated pawl. The jack body is directly connected to one end of the control surface. When the pawl is in position and hydraulic pressure is fed from the valve to one side of the jack piston, the jack body moves relative to the piston and deflects the control surface. When control column movement ceases, the valve closes causing a hydraulic lock which prohibits further movement of the jack body and control surface.



TYPICAL HYDROBOOSTER

(b) *In Manual*

(i) Manual operation of the controls may be selected deliberately by operating a switch in the cockpit (see para. 18) provided that electrical power is available, or will happen automatically if hydraulic pressure drops below 200 lb./sq. in.

(ii) When operating in Manual, control surface movements are achieved through a mechanical linkage. The spring-loaded hydraulically-operated pawls automatically disengage and release the anchored jack piston rods, allowing them and the jack bodies to move freely with the control surfaces. The controls are heavy in Manual, especially the ailerons,

but to avoid excessively high stick forces the spring-loaded hydraulically-operated pawls automatically disengage and release the anchored jack piston rod, allowing it to slide freely with the movement of the jack body.

(c) *Hydraulic power reserve*

Accumulators are fitted in the powered control circuits to provide a reserve of power if the main hydraulic supply fails. This reserve may be sufficient for a maximum of 3 complete cycles of aileron and elevator operation before the controls revert automatically to Manual, but even if no control movement is made, accumulator pressure will not be maintained for a long period due to seepage through the hydraulic components. With some types of hydraulic failure immediate reversion to Manual will result.

18. Controls and indicators

(a) *Pre-mod. 452*

Two ON/OFF switches (43) are on the instrument panel and control electrically the hydraulic cocks, one for the aileron circuit and the other for the elevator circuit. When the engine is running and a switch is selected ON hydraulic pressure is fed to that circuit and to the pawl which engages in the jack piston rod.

(b) *Post-mod. 452*

When mod. 452 is embodied a revised wiring and switching arrangement is applied to the aileron and elevator pawl release units so that Manual is automatically selected if any pawl disengages, even though momentarily. The aircraft can therefore be flown only with Power correctly engaged or in Manual. The two ON/OFF switches of unmodified aircraft are replaced by two ganged MANUAL-off-POWER selector switches which are spring-loaded to the central (off) position. Deflection upwards to POWER isolates the fail-safe circuit to allow initial engagement or re-engagement. Deflection downwards immediately selects Manual.

(c) Two magnetic indicators (42), one for the aileron circuit and the other for the elevator, are mounted beside the switches and show black when the piston rod locking pawls are correctly engaged and white when the appropriate pawl is disengaged or incorrectly engaged, or alternatively when electric power to the indicator is not available.

(d) A hydraulic pressure gauge (35) and a red warning light are fitted in the cockpit to warn the pilot if the pump is losing pressure.

(e) *Manual emergency selector buttons* (*Mod. 502*)

When Mod. 502 is embodied two yellow and black striped pushbuttons are fitted at the bottom left-hand corner of the instrument panel to permit the emergency selection of Manual of either ailerons or elevators or both, should the aircraft electrical system have failed. When either button is pressed an electrical supply from an independent dry battery is connected to the appropriate selector cock and the associated controls then revert immediately to Manual.

NOTE.—These buttons must not be pressed if normal electrical power is available as in this event it is likely that the control circuit fuse will be blown.

19. Aileron feel and trim

(a) On the ailerons, the piston rod is anchored to the aircraft structure, the air loads are resisted entirely by the hydraulic jack effort and no load is fed back to the control column. To provide control feel, a spring is fitted in the control circuit and gives an artificial stick force which is proportional only to aileron deflection but not to airspeed. When Mod. 188 is embodied a handwheel is fitted on the left-hand side of the control column to provide spring feel adjustment and should be used to counteract any out-of-trim forces which may occur when flying in Power. A white line is inscribed on the handwheel. When the trimmer is neutral the line points forward and the trimmer engages in a spring-loaded detent. Movement from this position is through 300° either to the left or to the right thereby adjusting the zero force position of the stick. Its use when flying in Manual is not recommended because its assistance is almost negligible and unless reset to its original position when reverting to Power it reduces the likelihood of a successful re-engagement.

(b) A trim tab is fitted on the port aileron. It is only intended for use in Manual and a guard (31) is placed round the trim control to prevent its inadvertent use when in Power.

(c) *Aileron gear change* (*Mod. 457*)

(i) With Mod. 457 embodied, the control column/aileron gearing is automatically changed when a reversion to Manual control is made, so that for the same stick movement aileron travel in Manual is approximately two-thirds of that obtained in Power.

(ii) This automatic changeover is provided for by the insertion of a hydraulic jack in the aileron control linkage. When hydraulic pressure is fed to the jack (via the aileron Power selector cock) the jack extends to alter the linkage effective arm. When hydraulic pressure is lacking the jack retracts under spring pressure.

20. Elevator feel and trim

(a) (i) *Power-assisted elevator*

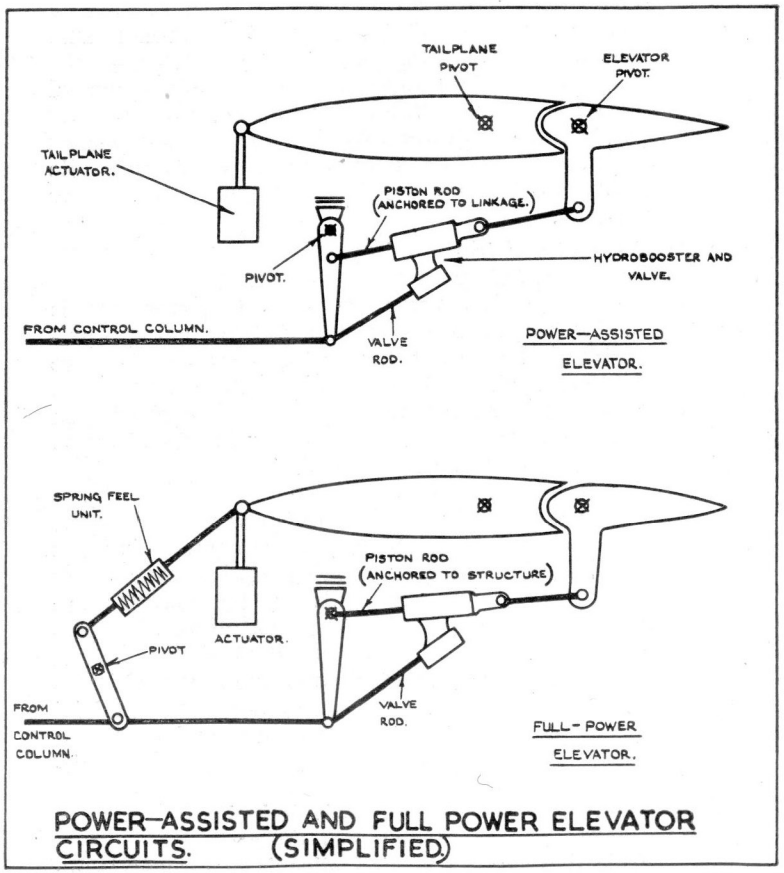
On the power-assisted elevator the piston rod is anchored to the control circuit itself, so that approximately $\frac{1}{4}$ of the air loads on the control surface are fed back to the stick, and changes of air load on the elevator will be felt by the pilot as changes of stick force, this providing a feel similar to that obtained from a normal manual control.

(ii) *Full-power elevator* (*Mod. 365*)

In aircraft fitted with the full-power elevator the feed-back previously built into the control circuit is eliminated by fixing the locking pawl to the aircraft structure and the air loads on the elevator are resisted entirely by hydraulic jack effort. To provide control feel, a spring is fitted in the control circuit between the control column and the variable-incidence tailplane. The spring gives an artificial feel to the elevator control circuit by imposing a force proportional to stick deflection but not to airspeed (i.e. air loads).

(b) (i) An electrically-operated variable-incidence tailplane is provided. It is hinged at the rear end, while a projection on the leading edge is connected to an electrically-operated actuator mounted in the dorsal fin below the tailplane. The actuator is operated by one of two electric motors, the main and the standby. The main motor is controlled by a thumb switch (60) on top of the stick and the tailplane operates in the

same way as a conventional trimming tab. After selecting by feel the required tailplane angle to give zero stick force for a given flight condition, the elevator is trailing with no air load imposed on it. The tailplane main motor circuit is protected by a circuit breaker (6) on the port shelf.



POWER-ASSISTED AND FULL POWER ELEVATOR CIRCUITS. (SIMPLIFIED)

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(ii) The standby motor, which is fitted to meet the case of failure, of the main motor, or its electrical supply, is controlled by a switch (28) under a cover on the port shelf. When the cover is raised to enable operation of the standby switch, the main motor circuit is isolated. The standby motor operates at about one-third the rate of the main motor.

(iii) The setting of the tailplane is shown on an indicator (45) on the port side of the instrument panel.

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21. Engaging power controls on the ground

(a) *Pre-mod. 452*

When hydraulic and electrical power are available the power selector switches should be switched ON and the control column moved to engage the power controls locking pawls. If, as is likely, the locking pawls are not opposite their slots, they clamp on the side of the piston rods; considerable force is then required to slide the piston rods and engage the pawls in the slots. When all pawls are correctly engaged the control column can be moved freely over its full travel in all directions, and is felt to come up against positive stops at the extremes of its movement. The indicators (42) will then show black.

(b) *Post-mod. 452*

To engage Power hold the appropriate selector switch to POWER with the left hand and move the stick with the right hand, laterally when engaging aileron and fore-and-aft when engaging elevator, until the corresponding magnetic indicator goes black. The switch can then be released. To engage aileron power more easily it is advisable either to:—

(i) Select POWER with the stick held hard over to starboard and then move it to port.

or (ii) Attempt the engagement immediately after light-up before hydraulic pressure builds up.

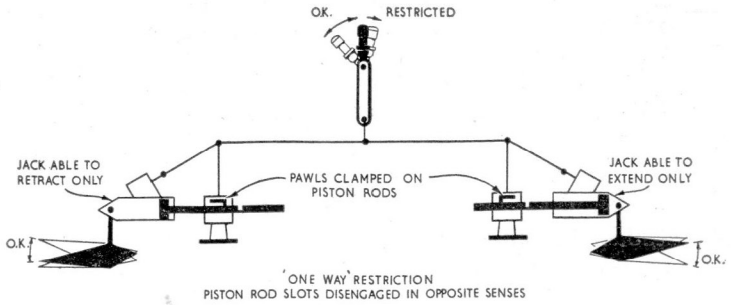
If Power has not been correctly engaged the controls will revert to Manual when the switch is released.

22. Re-engaging power controls in the air

NOTE.—The information concerning false anchorages applies mainly to aircraft without Mod. 452. When this mod. is embodied false anchorages can still occur when re-engaging Power in the air only so long as the selector switch is held at POWER.

When a reselection to Power is made in the air, it is possible that the locking pawls will not engage in the slots on the piston rods, but merely clamp on the side of the rods giving a false anchorage; the magnetic indicators remain white. False anchorages can be caused by the pistons "creeping" to full travel during a lengthy period of manual flying or when the ailerons are deflected appreciably either by the control column or by the presence of aileron up or down float when selecting Power ON or OFF. False anchorages can give two types of restriction.

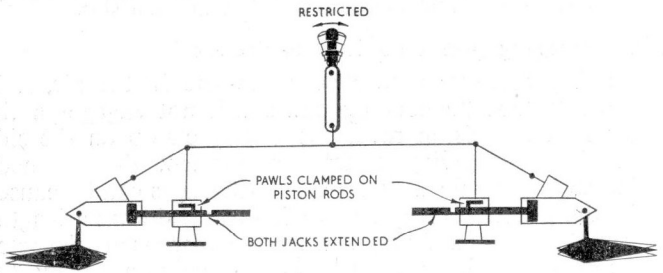
(a) *One-way restriction (See para. 86 (a))*



'ONE WAY' RESTRICTION
PISTON ROD SLOTS DISENGAGED IN OPPOSITE SENSES

This usually occurs as a result of reselecting power with the ailerons deflected, e.g. when initiating a turn. The locking pawls clamp on the side of the piston rods in opposite senses relative to the slots, e.g. one rod extended the other retracted. There will be apparent power-operated movement in one direction due to the clamping of the pawls on the rods. Movement of the control column in the other direction is restricted since power assistance is not available and not only has the friction clamp of both pawls to be overcome but the ailerons have to be deflected manually. This type of restriction can also occur as a result of having one pawl correctly engaged and one pawl out of engagement. Correct engagement of the pawls can be obtained by demanding a force greater than that which can be held by pawl friction, thus causing the piston rods to slide.

(b) *Both-ways restriction* (*See para. 86 (b)*)



'BOTH WAYS' RESTRICTION
PISTON ROD SLOTS DISENGAGED IN THE SAME SENSE

This usually occurs as a result of reselecting power ON with the ailerons floating up or down, e.g. when easing out of a dive. The pawls will grip the piston rods in the same sense relative to their slots, e.g. both rods extended or both retracted, giving complete jamming of the control column in the neutral position. Movement of the control column in either direction is restricted by the friction clamp of one pawl and the ailerons having to be deflected manually.

OTHER AIRCRAFT CONTROLS

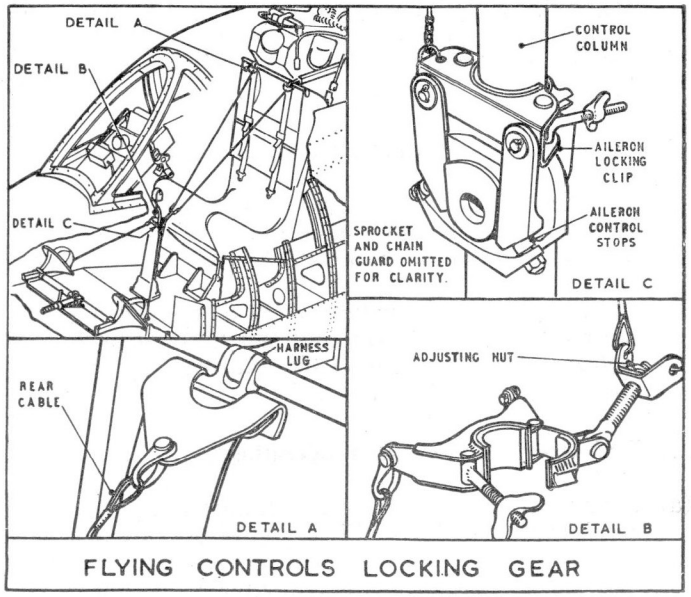
23. Rudder bar adjustment

The rudder bar is adjustable for leg reach by means of a control toggle (68) at the bottom centre of the instrument

panel. When the control is pulled out, a plunger is disengaged from a hole in the adjusting shaft, thus allowing the rudder bar arms to be pushed forward against the pressure of a spring, or to swing aft by spring pressure. When adjustment is complete, releasing the control to allow the plunger to engage in the nearest hole will fix the rudder bar in the desired position.

24. Flying controls locking gear

(a) *Internal locking*



FLYING CONTROLS LOCKING GEAR

The internal locking device consists of four cables which are joined to a clip, designed to attach to the control column. The other ends of the cables incorporate hooks which should be attached to the safety harness lugs on the ejector seat and to the outboard edges of the rudder pedals. When fitting the cables the rudder pedals should be in the central position and the cables tensioned by movement of the seat backrest pan.

(b) *External locking*
Locking clamps are provided for all flying control surfaces.

25. **Trimming tab controls**

The rudder and port aileron incorporate electrically-operated trimming tabs. A combined aileron and rudder trim control (31) is situated on the port shelf with a combined tab position indicator (30) just forward of it. The aileron trim tab must be set to neutral before take-off and must remain so at all times when power is engaged. A locking guard is provided to prevent inadvertent operation of the aileron trim when in Power. It must be engaged at all times when flying with ailerons in Power.

26. **Undercarriage control and position indicator**

(a) The tricycle undercarriage is operated hydraulically after electrical selection by either the UP or DOWN push-button (39), on the port side of the instrument panel.

(b) A standard position indicator (37) is fitted to the left of the pushbuttons. A warning light (36) below the push-buttons comes on if, with the undercarriage NOT locked up, the throttle is closed. AL.1

27. **Undercarriage emergency operation**

(a) Should electrical or hydraulic failure occur, the undercarriage may be lowered irrespective of the setting of the normal selectors by pulling the U/C emergency release (25), on the port shelf, while holding in the central knob. This admits air from an emergency bottle direct to the lowering jacks, forcing them to lower and lock. The available air pressure is shown on a gauge (9) at the rear end of the port shelf.

(b) If it is required to retract the undercarriage on the *ground only* the UP selector pushbutton should be twisted clockwise and then pressed. This is inoperative if the undercarriage emergency system has been used.

28. **Flaps control and position indicator**

(a) The flaps are selected electrically and operated hydraulically. Selection is by means of a switch (40), on the port side of the instrument panel, which provides UP, DOWN (80°) and six intermediate positions (15°, 23°, 30°, 38°, 45°, 60°).

(b) The flaps may be selected to any position but the extent to which they will lower depends upon the air loads. If speed is increased with the flaps extended, the angle will be adjusted to suit the air loads. (But see paras 55 (b) and 67 (d)).

(c) A flap position indicator is fitted adjacent to the selector switch.

29. **Flaps emergency operation**

Should electrical or hydraulic failure occur, the flaps may be lowered fully down only irrespective of the setting of the normal selector by pulling the emergency release (41), on the instrument panel, while holding in the central knob. This admits air from an emergency air bottle direct to the lowering jacks. The available air pressure is shown on a gauge (10) at the rear end of the port shelf.

30. **Airbrake control**

(a) An under-fuselage airbrake is provided. It is electrically selected and hydraulically operated and will extend fully at any speed.

(b) Control of the airbrake is by means of a three-position switch (20), spring-loaded to the central off position, on the throttle lever. No position other than fully in or fully out can be selected. A magnetic indicator (38) on the instrument panel shows black only when the airbrake is fully in.

(c) The airbrake is automatically inoperative when the undercarriage is lowered. If the undercarriage is lowered

when the airbrake is out, the airbrake will automatically retract. *Airbrake IN must not normally be obtained by selecting undercarriage DOWN.*

(d) A spring-loaded switch (14) on the port wall enables the airbrake to be tested on the ground. When the switch is held to TEST, the airbrake extends through 10° only and then retracts with a slight bump. The indicator shows white momentarily while the airbrake is out.

31. **Wheel brakes control**

(a) The wheel brakes are operated hydraulically by means of a lever attached to the forward face of the control column and a differential relay controlled by the rudder bar.

(b) The main hydraulic pressure (2,850 ± 150 lb./sq. in.) is shown on the triple pressure gauge (35) together with the pressure at each main wheel (1,500—1,650 lb./sq. in.).

(c) Should the hydraulic system fail, the pressure in the wheel brakes accumulators will be sufficient for landing but will leave little in hand for subsequent taxying. The available accumulator pressure is shown on a gauge (11) at the aft end of the port shelf.

(d) (i) Maxaret brake units are fitted and permit the use of full braking when essential without the danger of wheel locking and tyre damage. The units come into operation only if the wheels are rotating and in no circumstances should the brakes be applied before touchdown.

(ii) Should hydraulic pump failure occur, the brakes accumulators, if fully charged, should provide sufficient pressure for about 40 operations of the units. The brakes will remain effective until accumulator pressure drops to 750 lb./sq. in.

32. **Electrically-operated flight instruments**

(a) The turn and slip indicator is operated by D.C. whenever electrical supply is available. If electrical supply is lacking, the word OFF appears in the face of the instrument.

(b) The Mk. 3B or Mk. 4 artificial horizon is operated by A.C. (see para 16 (b)). In the Mk. 4 artificial horizon is incorporated a power failure indicator that shows the word OFF when electrical supply is lacking. If the fast erection button (47) is used before flight to erect the horizon, it must not be kept depressed after satisfactory erection is achieved. In flight the button should only be used in unaccelerated level flight.

(c) The Mk. 4F compass is also operated by A.C. (See para. 16 (b)). A test panel (86) is fitted at the rear end of the starboard shelf.

COCKPIT EQUIPMENT

33. **Entry to aircraft**

(a) Access to the cockpit is normally gained via a special ladder, supplied as ground equipment.

(b) A single emergency footstep is located in the port side of the fuselage, below the cockpit.

34. **Hood operation**

(a) The hood is opened or closed electrically after selection by a three-positioned OPEN-OFF-SHUT switch (22) on the port wall. The hood may be stopped at any position by selecting OFF but in flight the switch must be SHUT, otherwise partial depressurization may occur. There is a delay of about 5 seconds between selection and operation when the switch is set to OPEN. Above the switch is a clutch lever which when set to FREE declutches the actuator, locks the switch at OFF and enables the hood to be moved by hand. A circuit breaker (7) for the hood motor is fitted at the rear end of the port shelf.

(b) The hood seal is automatically inflated when the hood is fully closed, and deflated when either OPEN is selected or the clutch release is set to FREE.

(c) Four pointers (15) are provided, one at each end of the hood rails. Alignment of the pointers with their associated spigots indicates that the hood rails are locked and are safe for flight.

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35. Hood jettisoning

(a) *Pre-mod.* 281
The hood may be jettisoned mechanically by pulling the handle (34) on the port shelf. This action also operates a micro switch which, if electrical power is available, automatically lowers the gunsight.

(b) *Post-mod.* 281
The hood is jettisoned by gas pressure from a jettison gun acting on two pistons which release the hood rails and then push the hood upwards. This action may be initiated by pulling the hood jettison handle or will occur when either ejection seat handle is pulled. In the former case the G.G.S. is automatically lowered if electrical power is available, but in the latter case it will be necessary first to lower the G.G.S. manually.

(c) *External emergency release*
An external emergency release ring is inside a break panel on the port side of the fuselage. When the release ring is pulled the hood rails are released; in the case of aircraft fitted with Mod. 281 the jettison gun is not fired. The hood may then be lifted clear manually.

36. Cockpit pressurization, heating and demisting

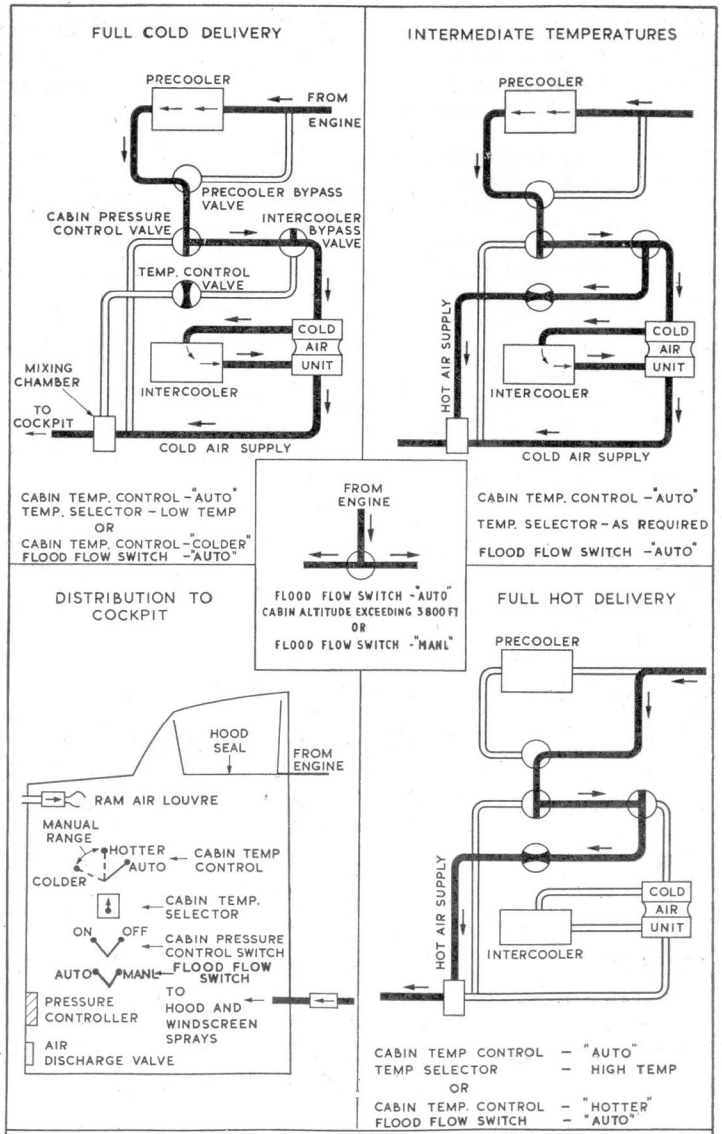
NOTE.—The system is inoperative whenever the hood is open.

(a) Hot air under pressure is bled from the engine compressor to supply the heating, pressurization and demisting system. The air supply to the cockpit terminates in spray pipes which provide for windscreen side panels and hood demisting.

(b) The master ON/OFF switch (3) controls the flow to the cockpit. The temperature control lever (2) permits the selection of AUTO or manual HOTTER-COLDER. The temperature selector (1) is for use in AUTO to pre-select the desired temperature, which is then maintained by a thermostat. In the manual range, temperature is controlled by first setting the lever to HOTTER or COLDER and then, when the desired temperature is reached, engaging the lever in the central gate.

(c) The cockpit altimeter (55) should indicate in accordance with the following table. Should the cockpit pressure drop below a pre-determined minimum, a red light (56) on the right of the instrument panel comes on.

Actual altitude	Cockpit altitude	Cockpit altitude at which warning light comes on
20,000 ft.	13,000 ft.	13,750 ft.
30,000 ft.	16,500 ft.	18,000 ft.
40,000 ft.	22,500 ft.	24,000 ft.



COCKPIT PRESSURISATION AND AIR CONDITIONING DIAGRAM

(d) (i) A "flood flow" valve is incorporated in the system, which may be controlled in AUTO or MANL according to the setting of the FLOOD AIR FLOW control switch (4).

(ii) When the switch is set to MANUAL, "flood flow" is brought into operation and is used primarily for clearing any transparency misting.

(iii) When the switch is at AUTO, should loss of cockpit pressure cause the cockpit altitude to exceed 38,000 ft., an altitude switch operates to supply "flood" air to the cockpit. In addition, an audio warning is transmitted over the pilot's head set. This warning may be silenced by the operation of the switch (59) on the instrument panel. When Mod. 327 is incorporated, the audio warning is connected to the hydraulic system and its use here is discontinued.

(iv) A switch (5) for *ground testing* the aural and visual warning circuits and flood air supply is to the rear of the normal controls. It must not be used in flight.

37. Windscreen de-icing system

The system consists of a tank containing the fluid, an electrical pump, a spray unit forward of the windscreen and an ON/OFF control switch (51) on the starboard coaming. When the switch is ON the pump operates to force de-icing fluid to the spray unit. When Mod. 581 is incorporated the system is deleted.

38. Anti-G suit system

(a) The purpose of the system is to provide air at low pressure for the pilot's anti-G suit, the connection for which is on the port side of the ejection seat.

(b) Air under pressure is stored in two air bottles, the contents of which are indicated by a pressure gauge (82) on the starboard wall. When the cock (80) below the

gauge is ON and G in excess of approximately $1\frac{1}{2}$ is applied, a spring-loaded valve operates and allows air to pass to and inflate the anti-G suit. The amount of inflation depends on the amount of G applied.

(c) The system may be tested, with the cock ON, by pressing the ANTI-G TEST button (81) adjacent to the on/off cock, as gently as possible to avoid severe discomfort due to too rapid inflation.

39. Ejection seat—Mk. 2H

(a) A Mk. 2H pilot ejection seat is fitted incorporating a type ZF harness, headrest, footrests, parachute container and a seat well for the dinghy and emergency oxygen supply.

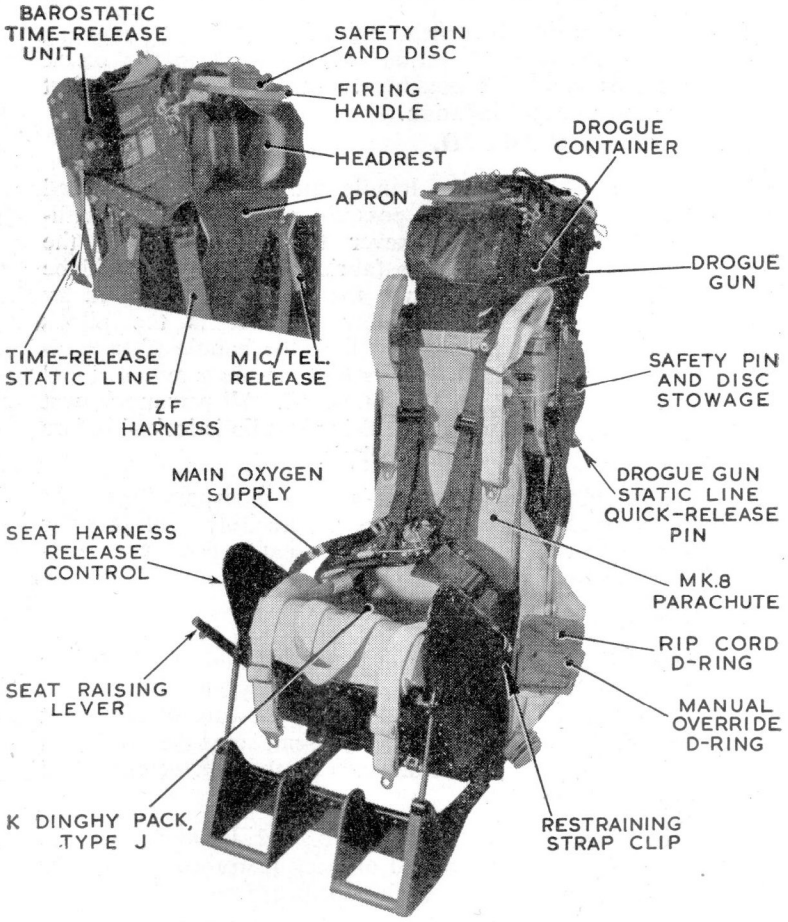
(b) The height may be adjusted by a lever on the starboard side of the seat; the harness release is also on the starboard side.

(c) The ejection gun is fired by pulling the handle above the headrest. When Martin Baker Mod. 423 (which supersedes Mod. 273) or Martin Baker Mod. 488 (on aircraft embodying Hunter Mod. 281, see (h) below) is embodied a secondary firing handle is fitted to the forward edge of the seat pan. This handle is intended for use when ejecting under positive G conditions. When either handle is pulled the ejection gun is fired and ejection follows. A stowage for the secondary firing handle safety pin may be provided on the outer face of the starboard thigh guard.

(d) All leads incorporate quick releases which are automatically broken on ejection.

(e) After ejection, at heights of 10,000 ft. and below, a barostat causes an automatic cycle to commence. After 3 seconds the safety harness is released as are the face screen, firing handle and headrest pad. An apron attached to the seat drogue then pitches the pilot head first out of the seat, at the same time opening his parachute.

(f) A manual override D-ring is fitted over the rip-cord D-ring and should be operated to isolate the automatic device if the system has failed.



EJECTION SEAT MK 2H.

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(g) (i) When Martin Baker Mod. 272 is embodied the foot-rests are removed and leg restraining cords are fitted in lieu; the thigh guards are retained.

(ii) The leg restraining cords ensure that the occupant's legs are drawn back automatically and restrained close to the seat pan during ejection, thus providing leg clearance and preventing the legs being blown apart after ejection. The cords should be fitted as follows:—

1. Secure the leg straps below the knees with the D-rings to the rear.

2. Pass the left nylon cord through the right-leg D-ring under the safety harness lap straps and insert the right shoulder harness eye-piece through the loop on the cord. Secure the shoulder harness in the quick release box.

3. Repeat for the other cord, passing the right cord through the left-leg D-ring and attach the loop to the left shoulder harness. Secure the harness.

(iii) The restraining cords are fastened to the floor in brackets, the rivets of which shear at 400 lb. force. The cords pass through snubbing units at the front of the seat pan. These units allow the cords to pass freely *down* through the unit, but prevent them passing *upwards*. Thus on ejection the cords are pulled downwards through the units pulling the legs close to the seat pan. The legs are held there until the safety harness is released. The cords are then pulled through the calf-strap D-rings and free the legs. A release button is provided under each snubbing unit to allow the occupant to adjust the cords to give comfortable leg movement in the aircraft.

(h) *Single lever ejection* (*Mod.* 281)

With Mod. 281 embodied, when either ejection seat firing handle is pulled the hood is jettisoned immediately by gas pressure from a hood jettison cartridge; at the same time a delay unit at the back of the headrest is started. This unit withdraws the sear from the seat one second after the handle is pulled. The seat is then ejected.

40. **Oxygen system**

(a) Oxygen is carried in two Mk. 5D cylinders. A Mk. 17 demand regulator controls the supply to the pilot.

(b) A contents gauge (57) is mounted on the right of the instrument panel. The regulator (74) is at the forward end of the starboard shelf. The regulator consists of an ON/OFF valve which controls the flow of oxygen, an air inlet NORMAL-100% OXYGEN switch, an emergency three-position switch and a combined flow and blinker unit.

(c) When the ON/OFF valve is on and the inlet switch is at NORMAL, an air/oxygen mixture is fed to the pilot's mask up to a height at which 100% oxygen is automatically delivered. When the inlet switch is at 100% OXYGEN, no air is added irrespective of the height. This position should be selected if any symptoms of anoxia or fumes are present. The emergency switch, when moved to either right or left, admits oxygen under greater pressure. Normally it should be central, but should be offset if cabin pressure failure occurs.

(d) The mask may be tested before flight by firmly pressing in the emergency switch, when in the central position. Oxygen is then supplied under pressure, the firmer the switch is pressed the greater the pressure (up to 5 times that obtained with the switch in either side position). The mask can then be adjusted until no leaks are present.

(e) *Emergency system*

A manual control (69) inboard of the starboard shelf is pulled up to turn on the emergency bottle, provided the safety pin on the bottle is withdrawn. Operation of the emergency system is automatic on use of the ejection seat.

41. **Internal lighting**

Three ON/OFF dimmer switches (77) are provided on the starboard wall for the control of the internal lighting. An emergency lamp switch (76) is on the starboard wall above the oxygen regulator.

42. **External lighting**

The navigation lights are controlled by an on/off switch (70) on the starboard shelf.

43. **Accelerometer**

The accelerometer (44) indicates all normal accelerations imposed on the aircraft by means of three concentrically mounted pointers. One pointer indicates instantaneous G, the other two register the maximum positive and negative G readings respectively until reset.

44. **Pressure head heater**

The heater element in the pressure head is controlled by a switch (64) below the centre of the instrument panel.

45. **Emergency equipment**

(a) *Crowbar*

This (12) is clipped to the cockpit port wall.

(b) *E.2 compass*

This (50) is mounted below and to the right of the GGS. Deviations of up to 12° must be expected when the GGS is in the combat position.

(c) *Aircraft destructor stowage*

Access to this is gained through a quick-release panel on the fuselage port side, level with the cockpit.

OPERATIONAL CONTROLS

46. **Gyro gunsight Mk. 5**

(a) The GGS is housed in a retractable mounting above the instrument panel. Retraction is controlled by an electric motor in circuit with the GGS on/off switch (48) on the right of the sight. An emergency lowering manual control (46) is on the left of the sight.

(b) The sight automatically provides for both manual and radar ranging. Altitude and ballistics units automatically compensate for the time of flight and gravity drop of the particular ammunition in use. The altitude unit is fully automatic but the ballistics unit must be pre-set for the particular ammunition before flight.

(c) The selector-dimmer control (26) on the port shelf contains a dimmer switch and a 5-position selector switch. The five positions are:—

G (gyro)	Moving graticule only is visible
F and G (fixed and gyro)	Both graticules are visible
F (fixed)	Fixed graticule only is visible. The sight may only be used as a reflector sight. Radar ranging not possible.
MRP (Medium RP) / SRP (Steep RP)	The sight is set for use with RP's.

47. **Radar ranging (ARI. 5820)**

(a) The radar ranging ON/OFF switch (27) is on the forward end of the port shelf. An adjacent magnetic indicator shows white when radar ranging is in use and black when its use is discontinued.

(b) Radar ranging automatically provides the GGS with target range information within the limits of 200-800 yards. The radar searches from maximum range down to minimum range until a target is found. If no target is found within the search area the search is automatically repeated. When a target is found the radar locks on to it, and a blue light (49) on the right of the GGS lights up to indicate this.

(c) A spring-loaded TARGET REJECT IN-OUT switch (24) is on the port wall. Its function is to unlock the radar from an unwanted target or to check that it is locked on to the correct target.

When IN is selected, the radar unlocks from the target and searches inwards to minimum range. If no fresh target is found the normal search cycle commences whether the switch is retained at IN or not. When OUT is selected the radar unlocks from the target and searches outwards to maximum range. It will remain at maximum range if the switch is retained at OUT, but when released the normal search cycle is commenced.

(d) To check that the radar is locked on the correct target set the span knob of the GGS to that of the target type. If the correct target is being ranged the GGS graticule should just encompass the target span. If the target span extends beyond the graticule (over ranging) or does not extend to the graticule (under ranging), the wrong target is being ranged and REJECT IN or REJECT OUT respectively should be selected.

NOTE.—1. When the manual twist-grip is set at a shorter range than that of the target, the radar cannot control the graticule until the target comes within the range set by the twist-grip, when the radar takes over the ranging.

2. When the twist-grip is set to minimum range, the radar is overridden. This is to enable the pilot partially to cage the GGS gyro during violent manœuvres.

3. When the desired target is near the ground (below 5,000 ft.) and the radar has locked on to the ground it is better to select REJECT IN than REJECT OUT to lock on to the target.

48. **VHF equipment**

(a) *ARI. 18064*

The two 10-channel VHF controllers (16), with an adjacent changeover switch (17), are on the port shelf. A press-to-transmit switch (19) is in the end of the throttle lever handle. The sets are stowed in the radio bay.

(b) *ARI. 18012*

The telebriefing land-line plug is at the underside of the rear fuselage, forward of the tail bumper. When the plug is connected the VHF circuit is de-energized and an amber warning light (23) on the port shelf indicates that telebriefing is in use. The pilot's press-to-speak button is adjacent.

(c) *ARI. 18044*

The control switches (21) are on the port wall. The indicator is positioned at (54).

49. IFF Mk. 3 GR (ARI. 5131)

(a) The G, G/D, F and D switches (79) are grouped on the starboard shelf.

(b) A suppressed aerial is mounted in the leading edge of the fin.

50. DME—Rebecca Mk. 7 (ARI. 5849)

(a) The control unit (89) is on the starboard shelf. A range and heading meter (53), which indicates range and left/right heading from the homing beacon, is on the instrument panel.

(b) Two suppressed aerials are fitted, one in the engine starter door and one in the engine access door.

51. G45 and recorder cameras

(a) The cine and recorder cameras are operated automatically whenever the gun or camera firing switch on the control column is energized, with the camera master switch ON.

(b) The camera master switch (65) is on the switch panel below the instrument panel. The aperture switch (58) is on the starboard side of the instrument panel.

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52. Gun firing

(a) The gun firing switch is on the forward face of the control column handgrip. The circuit is automatically isolated when the undercarriage is locked down. A butt test switch (88) is mounted on the starboard shelf and provides an override of the automatic isolation of the gun firing circuit.

(b) When the gun firing safety flap is raised an A.C. inverter is started up to provide electrical power for firing the guns.

(c) When the guns are fired, an electrically-operated selector is energized to open the gun bay scavenging flap. This causes air to clear the gases from the gun bay through the link and empty case chutes. When the trigger is released the scoop closes and the air flow is cut off.

53. Bomb release and drop tank jettisoning

(a) *Bomb release and jettison*

(i) The armament control panel (33) is on the port shelf. When the FUSING switch is set to NOSE or TAIL (as required), the BOMBS/RP switch set to BOMBS and the NORMAL/PRACTICE switch set as required, the bombs are released by pressing the bomb release pushbutton on top of the control column.

(ii) The bombs may be jettisoned in a safe condition by pressing the CLEAR A/C switch. (See (c) below.)

(b) *Drop tank jettisoning*

When the bomb fusing switch is set OFF, both inboard drop tanks are jettisoned by pressing the bombs release pushbutton.

(c) *'Clear aircraft' switch*

When the bomb fusing switch is OFF, all stores, drop tanks or bombs, carried on the pylons are simultaneously jettisoned by pressing the CLEAR A/C switch (50), on the left on the GGS.

PART II

LIMITATIONS

54. Engine limitations—Sapphire Mk. 101

Power rating	Time limit	R.p.m.	J.p.t. °C.
Take-off and Operational Necessity	15 mins. (Combined)	8,600 ± 50*	660
Intermediate	30 mins.	8,400	620
Max. Continuous	Unrestricted	8,200	580
Min. Approach	Unrestricted	5,000	—
Ground idling	Unrestricted	3,000 + 200 —0	570

Min. oil pressure in flight at
8,200 r.p.m. and above ..... 20 lb./sq. in.

*Due to control system characteristics the maximum r.p.m. vary with altitude. Up to 20,000 ft. maximum r.p.m. increase to approximately 8,700, which speed is permitted for a period of 5 minutes duration. Above this altitude maximum r.p.m. decrease progressively to approximately 8,350 at 50,000 ft.

55. Flying limitations

(a) Intentional spinning is prohibited. Stalling practice is is not to be carried out below 25,000 ft. nor continued beyond the buffet stage.

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(ii) Drop tanks, 1,000 lb. bombs or 25 lb. practice bombs may be carried on inboard pylons, subject to the observance of the limitations below. When carrying stores, other than empty inboard drop tanks, practice selections of Manual must not be made since the presence of such stores increases the difficulties of re-selecting Power. Gun ammunition must be carried to maintain the C.G. within reasonable limits during take-off.

(iii) When dropping bombs, if 0.9M is exceeded care must be taken that sufficient height is available for dive recovery because of the reduced longitudinal control at these high speeds.

(b) *Maximum speeds*

In power

Clean	620 knots; no Mach limit, but see paras. 72 and 73
With drop tanks or 1,000 lb. bombs	590 knots; no Mach limit, but see paras. 72 and 73
With 25 lb. bombs	
No. 1 Mk. 1. 0.025 in. vanes*	400 knots (No Mach Limit)
No. 1 Mk. 1. 0.037 in. vanes*	500 knots (No Mach Limit)
No. 2 Mk. 1	500 knots (No Mach Limit)
(*Minimum thickness)	

In Manual

Clean or with stores	0.75M below 15,000 ft. 0.85M above 15,000 ft. (If inadvertent Manual reversion occurs at higher speeds reduce speed immediately.)

For drop tank jettisoning

Drop tanks jettisoning must be carried out in straight and level flight without yaw or sideslip in the speed ranges quoted:

Drop tanks without fins	250–300 knots
Drop tanks with fins	200–450 knots

For bomb release and jettisoning

Any speed within the limitations for carriage and up to 60° dive angle.

For the operation of the:

Undercarriage	230 knots
Flaps over full travel	250 knots (See para. 67(d))
Flaps to or from 38°	300 knots or 0.9M (See para. 67 (d))

NOTE.—The speeds for the operation of a service also apply for flight with the service in the extended position.

(c) *G limitations*

(i) The following accelerometer readings must not be exceeded, clean or with drop tanks:—

At any height	+7G
Between 10,000 ft. and 30,000 ft.	*Below* 0.90M. The reading at which buffeting commences. *Above* 0.90M. +4G

(ii) An accelerometer reading of $-3\frac{1}{4}$G must not be exceeded at any height.

(d) *Loading data—all-up weights*

Max. for take-off and all forms of flying:—

With drop tanks or bombs	19,500 lb.
Clean	17,250 lb.
Max. for landing	15,600 lb.

(e) *Special limitations*

(i) *Misting.* Ample time must be allowed for demisting after a rapid descent from a long cruise at high altitude; so far 5 minutes has been sufficient, but experience on aircraft without manual control of flood flow indicates that up to 15 minutes might be necessary.

(ii) *Undercarriage operation at high altitude.* Pending further trials, the undercarriage should not be lowered (e.g., for stalling practice) above about 25,000 ft.

(iii) *Drop tanks.* The carriage of drop tanks on inboard pylons is permitted for ferrying purposes only. A.L.1.

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(f) *Gun firing*

(i) Gun firing is permitted within the limitations imposed by the modification state listed below:—

Mod. State	Mod. No.
1	273 (Part A), 285, 289, 295, 301, 302, 336, 451, 478 (Part B).
2	State 1, + 434, 435.
3	State 2, + 413, 462, 478 (Part A), 484, 506, 521, 523, 552, 570, 571, 572, 573, 577, 581, 585.
4	State 3, + 592, 598.

(ii) The following table lists the gun firing limitations as dictated by the mod. state.

Mod. State	No. of guns	Type of ammo.	Max. length of burst (secs.)	Min. Interval between bursts (secs.)	Max. height (ft.)	Max. IAS (kts.)
1	4	L.V. only	1½	3	48,000	400
2	4	L.V.	1½	3	48,000	400
2	4	H.V.	1½	3	0-25,000 25-48,000	250 350
3	2	L.V. or H.V.	—	—	48,000	550
3 plus Mod. 646	2	L.V. or H.V.	—	—	48,000	620 (See Note 2)
4	4	L.V. or H.V.	—	—	48,000	550
4 plus Mod. 646	4	L.V. or H.V.	—	—	48,000	620 (See Note 2)

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NOTE.—1. When carrying drop tanks the minimum firing speed is 350 knots. When Mod. 645 is embodied this speed is reduced to 150 knots.
2. Air firing at speeds above 550 knots with airbrake OUT may be carried out when operationally necessary but a limited number of ejected case strikes will be experienced.

PART III
HANDLING

MANAGEMENT OF SYSTEMS

56. **Management of the fuel system**

(a) The L.P. and H.P. cocks must be ON and except for starting, and taxying after landing, the booster-pump switches should be ON (modified aircraft) or at AUTO or MANUAL (unmodified aircraft) at all times when the engine is running.

(b) *Modified aircraft*

Fuel is supplied to the engine from the front tanks by the booster-pumps. The front tanks are kept full with fuel transferred by air pressure from the drop tanks via the wing and centre tanks. With the booster-pump switches ON equal flow should be provided from both front tanks.

(c) *Unmodified aircraft*

(i) With booster-pump switches set to AUTO, fuel balancing is achieved by the fuel feeding alternately from the port and starboard tanks. The fuel gauges electrically monitor the output of the booster-pumps. The low-side gauge reduces the output from its booster-pump and only the high-side pump supplies fuel to the engine until the situation is reversed, because its higher output pressure prevents fuel flowing from the low-side. Thus fuel balancing will only function when the gauge readings begin to fall.

(ii) In aircraft with wing tank fuel ungauged all the fuel from one wing tank plus a small amount from the centre tank on the same side will be used before the

gauge senses that one side is low and causes that booster-pump to operate at reduced output. Fuel is then fed from the other side. The asymmetric flow is indicated by a gradual wing-low effect which, in power control, is hardly noticeable. (See para. 83 (c)).

(iii) When drop tanks are carried the booster-pumps switches should be set to MANL until the wing tank magnetic indicators show white; then set to AUTO. This is to avoid the out-of-trim effects which will occur due to the asymmetric fuel flow described in (ii) the effects of which in this case will be of a greater magnitude.

(d) *Unusable fuel*

(i) Provided slow forward throttle movements and small changes in attitude are made the engine will continue to run satisfactorily down to zero gauge readings, but at low fuel states steep climbs and/or sudden application of full power should be avoided, particularly when overshooting, as this will cause fuel in the tanks to move away from the booster-pumps resulting in a possible fuel starvation and flame extinction. Therefore at low fuel states minimum power consistent with safety should be used, steep attitudes avoided and a glide approach planned. If a flame-out occurs, a relight may be obtained by adopting a nose-down attitude and pressing the relight button.

(ii) The amount of unusable fuel increases with sudden forward acceleration and/or nose-up attitude: rig tests reveal the following:—

Angle between fuel surface and fuselage datum	Unusable fuel galls. per side
10°	16
20°	26
30°	30

In the normal unstick attitude, the angle between fuel surface and aircraft datum is approx. 23°, at which angle approx. 27 galls. (208 lb.) per side are unusable.

(e) *Unequal tank emptying*

(i) Unequal emptying (to the extent of 100 lb. or more) will result from either balance control failure or booster pump failure. The contents gauges and booster-pump failure warning lights (when fitted) should be checked frequently to ensure that fuel balancing is being maintained. If a booster pump fails any resulting inequality in fuel levels cannot be corrected. Both pumps should therefore be turned off (see sub-para. (f) below).

(ii) To check for booster-pump or balance control failure in aircraft without booster-pump failure warning lights, switch off the pump on the low contents side; if the low pressure warning indicator then shows white the " high-side " booster-pump has failed, if it remains black automatic balancing has failed. If the latter occurs balancing must then be obtained by use of the individual booster-pump switches between the MANUAL and OFF positions (or ON and OFF positions in aircraft fitted with a flow proportioner) i.e. switching off the pump on the low contents side until the fuel contents are level, then switching both pumps to MANUAL (or ON in modified aircraft).

(iii) With the booster-pump failure warning lights fitted the operating pressure of the low pressure warning indicator is reduced to $3\frac{1}{2}$ lb./sq. in., it will not go white when both booster-pumps are off; in this case balance control failure is indicated by unequal emptying with the booster-pump failure lights out.

(f) *Booster-pump failure*

(i) If a booster-pump fails, reduce r.p.m. to approximately 6,500, switch OFF both pumps and accept the fuel feed provided by tank pressurization and gravity. Open the throttle until the minimum r.p.m. to maintain height is obtained or engine roughness is encountered, whichever occurs first. If necessary

reduce altitude and r.p.m. until a satisfactory combination is obtained and return to base. With both pumps OFF the engine will run satisfactorily provided there is fuel in both sides and maximum level flight conditions should be obtainable at sea level, but it is advisable to avoid using excessively high r.p.m. Since the engine will not run with one side of the fuel system empty unless the booster pump is operating on the side containing fuel it is important to land while both sides still contain fuel. If the fuel state permits, the serviceable booster-pump should be switched ON prior to landing.

NOTE.—In tropical climates leave the serviceable booster pump ON and land as soon as possible while there is still fuel in both sides.

(ii) With both booster-pumps OFF, fuel cavitation may occur in the engine pumps, causing engine roughness or loss of r.p.m. This is more likely to occur at high fuel flows, high fuel temperatures, high altitude, or in a climb and immediately afterwards.

(g) *Transfer failure*

(i) The fuel transfer indicators should remain black throughout the flight. If one or both show white, air pressure failure has occurred and steep dives should be avoided due to the possibility of collapsing the tanks. Should an indicator show white before transfer is complete, any fuel remaining in the rear and centre tanks will be unusable and the associated contents gauge will only indicate the fuel in the front tanks (770 lb. (100 gallons) max. per tank). In these circumstances if the gauge registers more than the total contents of a front tank a faulty gauge should be suspected and only the front tank fuel should be relied on as being available to the engine. The booster-pump on the side with air transfer failure should be switched OFF until the contents gauge of the other side indicates an equal amount; then reset the switch to AUTO (unmodified aircraft), or ON (modified aircraft).

(ii) A fuel transfer indicator may show white when the rear and wing tanks are empty or nearly empty. This is caused by the hymatic valve freezing. If it occurs only the fuel in the front tanks will be available to the engine. Since this only occurs when all or nearly all the fuel from the wing and rear tanks has been transferred it is not serious from a fuel point of view; however, rapid climbs and descents should be avoided otherwise the fuel tanks may collapse.

(*h*) *Gauge failure*

(i) *Aircraft with fuel proportioner*
Total or partial gauge failure will not affect fuel flow. Check that neither booster pump nor transfer failure has occurred, leave both pumps ON and return to base.

(ii) *Aircraft with fuel gauge monitored booster pumps*
Total or partial gauge failure will quickly result in an out c balance fuel state. Switch both pumps to MANL and retur to base.

57. **Engine handling**

(a) *Take-off and climb*
During the initial climb to 10,000 ft. at full power, r.p.m. may increase to 8,700, but above that height a negative creep device gradually reduces r.p.m. with height to maintain j.p.t. within limits. As a result full throttle r.p.m. at 40,000 ft. will be about 8,400/8,550 and at 50,000 ft. 8,300/8,450. However, when climbing at intermediate r.p.m. above 8,000, but not at full power, it may be necessary to *reduce* the throttle setting to maintain the selected r.p.m.

(b) *General*
The AFC is designed to give optimum engine acceleration at all altitudes. Rapid engine accelerations and decelerations may be made at all altitudes.

(c) *Approach conditions*
During the approach to land, if r.p.m. are maintained at 5,000, full thrust can be obtained within 5 seconds. If less r.p.m. are used the time to attain full thrust is considerably increased.

(d) *Flame-out*
If flame-out occurs, carry out the relighting drill (see para. 91). It must not be assumed that combustion has ceased unless r.p.m. fall below 3,000.

58. **Management of the flood flow system**

NOTE.—Pending modification action to improve the system, MANUAL flood control must not be selected below 15,000 ft. at r.p.m. exceeding 7,000. When Mods. 209, 291, 321, 322 are all incorporated, all restrictions on the use of the system are removed.

(a) For all normal conditions of flight the FLOOD AIR-FLOW CONTROL switch should be at AUTO. To prevent windscreen misting MANUAL should be selected:—

(i) When cruising for prolonged periods at high altitude and low engine r.p.m. e.g., more than 15 minutes above 30,000 ft. at 7,200 r.p.m. or less (see (b) below).

(ii) For descents using less than 7,000 r.p.m. after high altitude cruising until misting has cleared or misting danger has passed. (See (c) below and NOTE.)

(b) If misting occurs above 30,000 ft. when cruising at 7,200 r.p.m. or above, keep both the FLOOD AIR CONTROL and the CABIN TEMP. CONTROL switches at AUTO and select full heat on the CABIN TEMP. SELECTOR.

(c) If descending with r.p.m. above 7,000 keep the FLOOD AIR CONTROL switch at AUTO and select HOTTER on the CABIN TEMP. CONTROL.

STARTING, TAXYING AND TAKE-OFF

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59. External checks

The outside of the aircraft should be checked systematically for signs of damage and for security of panels, filler caps, doors and the like. The engine intakes and boundary layer ducts must be free from obstruction and the jet pipe free from distortion. The main and nosewheel oleos should be checked for extension, the tyres for cuts and creep, and the brake leads for security and leaks. The elevator accumulator gauge in the port side of the fin should read 1,575 lb./sq. in. and the ailerons accumulators gauge in the starboard wheel bay should read 1,575 lb./sq. in. (900 if Mod. 690 is embodied). Remove the pressure head cover.

60. Cockpit and pre-start checks

(a) On entering the cockpit and before strapping in, check that the drogue gun safety lock and emergency oxygen bottle pins are removed, that the flight instruments and radar supply circuit-breakers are in and the test switch is at NORMAL FLIGHT (see para. 16 (b)). Check that the hood rail locking indicators (15) have their pointers in line with the centres of the pins.

(b) Strap in, adjust rudder pedals, and connect radio, oxygen and anti-G suit; have the seat safety pin removed and stowed.

(c) Put on the battery master switch, ensure that the turn and slip indicator starts up, then check the cockpit from left to right:—

NOTE.—The starred items are directly connected with engine starting.

Item	*Check*
Undercarriage emergency air pressure gauge (9)	Pressure 1,800-2,000 lb./sq. in.
Flaps emergency air pressure gauge (10)	Pressure 1,800-2,000 lb./sq. in.
Wheel brakes accumulator air pressure gauge (11)	Minimum pressure 750 lb./sq. in. (1,550 lb./sq. in. on unmodified aircraft).
Tailplane actuator and hood motor circuit-breakers (6) (7)	In.
Radar test switch (8)	Switch to TEST. Check aurally that the stand-by inverter starts up, and that the gyro instruments start erecting. Switch to NORMAL.
Cockpit pressure warning test switch (5)	Switch to TEST check cockpit altimeter warning light comes on. Switch to NORMAL.
Cockpit pressurization switch (3)	ON (In conditions of high humidity, to avoid internal misting on take-off, leave OFF until 5,000 ft. is reached).
Cockpit temperature control (2)	Auto.
Cockpit temperature selector (1)	As required.
Flood flow control switch	AUTO.
*L.P. cock (13)	ON.
*H.P. cock (32)	Set ON and press relight button. (If serviceable a clicking sound is heard.) Set OFF.
Throttle damper (18)	Adjust as required.
*Throttle	Half-open.

Item	*Check*
Hood control switch and clutch selector (22)	Clutch FREE, check manual operation of hood. Clutch LOCKED. Switch as required.
Undercarriage emergency selector (25)	Ensure selector not pulled up.
Undercarriage position indicator (37) and selector buttons (39)	Day/Night switch. Bulb changeover switch. Three green lights. Undercarriage warning light out. Down button fully in
Flaps emergency selector (41)	Ensure selector not pulled out.
Hydraulic pressure warning light	On.
Power control switches (43)	Both OFF. (CENTRAL IF MOD A52 EMBODIED) A.L.1.
Hood jettison handle (34)	In.
Flight and engine instruments	Condition.
Generator failure warning lights (61)	On.
*Ignition switch (66)	ON (normally locked on).
Windscreen de-icing switch (51)	OFF.
Fire warning light (52)	Off. Pull out spring-loaded button to test, then reset. Do not allow button to spring back in. (If test switch fitted, use that in lieu of above check.)
Audio warning cut-out switch (59)	ON (Normally spring-loaded in the ON position).
Fuel pressure warning indicator	Black until engine master switch is on.
Cockpit altimeter (55)	Reading.

Oxygen (74)	Main and emergency supplies connected. Contents and delivery. Stopcock ON. 100% A.L.1 Air inlet ~~NORMAL~~ OXYGEN. Test for mask leaks. Blinker operation. Emergency switch central.
Fuel contents gauges (73)	Contents with ENG. ON/OFF switch at ENG. OFF. Fuel transfer indicators white (if pressure is still in the system these will be black and contents gauges will read full).
*Fuel booster-pump switches (78)	OFF.
Booster-pump failure warning lights (when fitted)	On.
*Fuel booster-pump and engine starter circuit-breakers (84) (85)	All in.
External light switches (70)	As required.
Oxygen emergency selector (69)	Down.
Anti-G control (80)	Switch ON. Check pressure 1,800-2,000 lb./sq. in. Test. Then as required.
Flying controls	Full and free movement. *
Brakes	On. Check pressure at each wheel. If brake accumulator pressure is between 750 and 1,500 lb./sq. in. each brake needle should read accordingly.

* ROTATE SPRING FEEL TRIM FULLY IN BOTH DIRECTIONS. CHECK STICK MOVES LATERALLY IN SAME SENSE, RETURN TO NEUTRAL.

61. Starting the engine

NOTE.—The maximum permitted j.p.t. during starting is 750° C. Should this temperature be exceeded the H.P. cock must be closed immediately.

(a) Starter master switch — ON. Check aurally that No. 1 inverter starts up, the gyro instruments erect and the fuel pressure warning indicator shows white. (If residual pressure remains in the system the indicator may remain black).

H.P. cock — ON.

Press the starter button without delay.

(b) The cartridge fires over a period of approximately 4 seconds during which time light-up should occur. The engine should accelerate to the idling r.p.m. $3{,}000^{+200}_{-0}$ in approximately 11 seconds. The throttle should be closed when engine speed is approaching 3,000 r.p.m. The starter button remains in for approximately 30 seconds after it was initially pressed.

NOTE.—If the engine lights up, as indicated by the j.p.t. registering, but r.p.m. then drop below 1,400, immediately close the H.P. cock.

(c) When r.p.m. have stabilized, check that the j.p.t. has returned to normal and the oil pressure is registering (off the stop).

(d) *Failure to start*

(i) If the cartridge does not fire, close the H.P. cock immediately. It must not be assumed that the breech is empty. In all cases allow one minute to elapse before attempting a further start. If the second cartridge fails to fire, have the defect investigated.

(ii) If the cartridge fires but the engine fails to light up, close the H.P. cock without delay. Always allow the engine to stop turning before making a further attempt to start.

(iii) If, due to a circuit fault, the starter button does not hold in, irrespective of whether a cartridge is fired or not, a period of one minute must elapse before the button is again pressed.

(iv) If the safety disc bursts, as indicated by intermittent clouds of black or yellow smoke from the turbine exhaust and no r.p.m. indication, wait until the cartridge stops burning and have the fault rectified.

(v) The run of the time switch must not be shortened by the use of the master switch, otherwise overspeeding of the starter may occur in some circumstances.

62. Checks after starting

Fire warning light	Out.
Set 3,700 r.p.m. and check:—	
Generator warning lights	Out.
Fuel transfer	Indicators black.
Booster-pump switches	OFF check as below. With both switches off, the low pressure indicator should show white, then ensure that as each switch is set in turn to AUTO. and MANUAL (ON in aircraft fitted with flow proportioner) the low pressure indicator shows black, leave at AUTO (or ON). On aircraft fitted with booster-pump failure warning lights, switch ON each pump and check that the lights go out; the L.P. indicator should be black with booster-pumps On or Off.
Instruments	Correct functioning. Compare Mk. 4F compass with E.2 Switch on pressure head heater and G.45 camera if required. Erect artificial horizon.

Hydraulic pressure	3,000 ± 150 lb./sq. in. on both centre needle of triple pressure gauge and brake acc. gauge. Pressure at each wheel brake 1,500 lb./sq. in. (min.). Warning light out.
Elevator and ailerons	Select power control switches ON. Engage controls by moving the control column through its full traverse (using two hands if necessary) until free movement is felt. Indicators black.

If Mod. 452 is incorporated, hold the selector switch to POWER with the left hand and move the control column with the right hand, laterally when engaging ailerons and fore and aft when engaging elevator, until the corresponding magnetic indicator goes black. The switch can then be released. To engage aileron power more easily it is advisable to either:

(a) select POWER with the stick held hard over to starboard, then move it to port, or

(b) attempt the engagement immediately after lighting before hydraulic pressure builds up.

If Power has not been correctly engaged the controls will revert to Manual when the switch is released.

Flaps	Check operation.
Tailplane actuator	Test through full range on emergency lower cover then check on normal and set at 0°. The stick should move forward as nose-down trim is applied and vice versa.
Rudder and aileron trimmers	Check and set neutral. Lock engaged.
Airbrake	Check operation with test switch.
V.H.F.	Frequency selected. DME (if fitted) switch to STANDBY.

NOTE.—1. To check the correct functioning of the hydraulic failure warning light and audio warning, exercise the stick laterally several times and select full flap simultaneously to exhaust hydraulic pressure. The light should come on and the audio warning sound when pressure falls below 650 lb./sq. in. When pressure rebuilds check that the flying controls magnetic indicators are still black. If the flying controls revert to Manual during this check they should be re-engaged as appropriate.

2. When Mod. 457 is embodied, if a check on low geared Manual aileron is required, apply full lateral stick deflection and switch to Manual, observing a decrease in aileron angle. Re-switch to Power and check aileron reverts to its original position.

63. **Taxying**

(a) Taxying is normal for a nosewheel aircraft.

(b) Fuel consumption is about 2 gallons per minute whilst taxying.

(c) Whilst it is desirable to keep r.p.m. above 3,700 whenever possible to avoid discharging the batteries and to prevent No. 1 inverter cutting out with the subsequent loss of the Mk. 4F compass, Art. Hor. and oil pressure gauge, the aircraft should not be taxied at a speed which requires excessive use of the brakes as this causes overheating of the tyres and reduces their life.

64. **Checks before take-off**

Trim	Tailplane 0° (1° n.u. if carrying drop tanks). Rudder—neutral. Ailerons—neutral, lock on. Spring feel—neutral.
Fuel	Booster-pumps ON or AUTO (MANL if drop tanks carried). Warning lights (when fitted) out. Fuel pressure indicator black. H.P. cock ON and locked. L.P. cock ON. Transfer indicators black. Contents.
Flaps	Up (38° if carrying drop tanks).
Instruments	Check and set. Pressure head heater ON.
Oxygen	100% Oxygen. Emergency switch central. Blinkers operating.
Harness	Tight and locked.

Hood	SHUT (not OFF). Clutch LOCKED. Cockpit pressure ON (OFF in conditions of high humidity).
Hydraulics	Flying controls in power. At 4,500 r.p.m. apply full aileron and elevator and ensure that the magnetic indicators remain black. Warning light out.

65. **Take-off**

WARNING.—*A check that the power controls indicators are black must always be made immediately before take-off at not less than 4,500 r.p.m.* At any stage of a flight, if either automatic Manual reversion or any form of stick jamming occurs with Power selected ON, immediately switch Power OFF. Do not attempt to re-engage Power; return to base and land in Manual.

(a) Having aligned the aircraft apply the brakes, open the throttle smoothly. When the aircraft begins to creep forward at between 7,500 r.p.m. and full throttle, depending on brake condition, release the brakes and open up to full throttle. At full power, check that the oil pressure is at least 15 lb./sq. in. If the aircraft creeps forward before 7,000 r.p.m. is reached, the brakes should be considered unserviceable and the aircraft should not be flown. Settled r.p.m. on take-off may vary from 8,500 to 8,650. On rapid throttle opening there may be an overswing of 250 r.p.m. and an underswing of 200 r.p.m. which should damp out in three cycles.

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(b) In crosswind conditions, gentle intermittent braking is necessary to keep straight until at about 90 knots the rudder becomes effective.

(c) Ease the nosewheel off at about 120 knots and hold it just off the runway, taking care not to achieve an excessively nose-up attitude. At about 150 knots, depending on weight, apply gentle back pressure to unstick.

(d) Until experience is gained the lightness of the ailerons may lead to overcontrolling, resulting in lateral rocking as the aircraft leaves the ground.

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(e) When comfortably airborne apply the brakes and raise the undercarriage. There is no noticeable change of trim, but the nosewheel locks up with a distinct thud. *Retraction must be complete before 230 knots may be exceeded.*
To ensure that the wheels do not rotate in their bays when the undercarriage is locked up, keep the brakes on until the red lights go out.

(f) As the aircraft accelerates to climbing speed it will be necessary to trim out the increasing nose-up change of trim.

(g) *Use of flap for take-off*
Only a short reduction in take-off distance is achieved by using 38° flap, but the distance to 50 ft. is appreciably decreased. In this configuration lateral rocking is more pronounced; a strong nose-up change of trim and a small amount of sink occur when the flaps are raised. It is recommended that flaps should not be used during formation take-offs.

(h) *When carrying stores*
Using 4 notches of flap (38°) and 1½° nose-up trim the nosewheel can be eased off at 125 knots and the aircraft flown off at 145–150 knots, the unstick distance being approx. 1,550 yards. When safely airborne immediately raise the undercarriage and then the flaps one notch at a time retrimming after each selection; delay in raising the flaps will result in an increasing nose-down change of trim as speed increases.

(j) *Manual reversion*
(i) Should Manual reversion occur on take-off it is safe to continue the take-off, circuit and landing. Using the recommended trim settings, a strong pull force is required to raise the nosewheel but the aircraft will be in trim at 160 knots.
(ii) It is recommended that, because of there being a possible hydraulic failure, undercarriage and flaps (if the latter have been used for take-off) are left down, care being taken not to exceed the maximum permissible speed.

HANDLING IN FLIGHT

66. **Climbing**

NOTE.—If cockpit pressure has been set to OFF for take-off, switch it ON at about 5,000 ft.

(a) (i) *Best rate of climb*
Climb at maximum power within the j.p.t. and r.p.m. limits at 430 knots until 0.87M. is reached. Thereafter maintain 0.87 M.

(ii) For the best rate of climb, it is important to keep to the recommended speed especially at high altitudes. Above 30,000 ft. the rate of climb will fall off

quickly if the airspeed is reduced to below that recommended, and it will take a long time to regain speed without losing height.

(b) *Normal climb*

If maximum rate of climb is not essential set 8,400 r.p.m. using the same airspeeds as above. It may be necessary to adjust the throttle as height is gained to maintain the selected r.p.m.

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67. General flying

(a) *Flying controls*

(i) *Ailerons* (*in power*). The ailerons are light throughout the speed and mach number range, giving a high rate of roll. (See para. 71.) The aileron spring feel trim should normally be used to counteract any out-of-trim forces which may occur in Power. It should not normally be used when flying in Manual.

(ii) *Power-assisted elevator* (*in power*). The control is light and effective up to 450–500 knots, but at higher speeds it becomes heavy and loses some of its effectiveness. Above 0.92M there is a marked decrease in control effectiveness and a substantial heavying up.

(iii) *Full-power elevator* (*in power*)

The force required for any manœuvre depends on the distance the control column is displaced from the " zero-load " position. It follows therefore that when large elevator deflections are required, e.g. at low airspeeds and very high mach numbers, the stick forces are relatively heavy; at high airspeeds, however, since only small deflections are usually required, the stick forces are light. The control is light, effective and should be used cautiously especially at high I.A.S. until its characteristics are known and its effectiveness appreciated. However, elevator effectiveness is somewhat limited by jack stalling, which occurs when the air load on the elevator equals the jack output force and restricts movement of the control column rearwards. When manœuvring, jack stalling may occur above 0.93M depending on tailplane angle and C. of G. and if it occurs, the tailplane must be resorted to for control.

(iv) *Rudder*. The rudder is light at low I.A.S. but becomes progressively heavier as speed increases. The application of rudder produces a strong rolling tendency.

(b) *Trimmers and tailplane*

NOTE.—Do not fly with the thumb on the tailplane control switch as this may cause intermittent making and breaking of the contacts which may damage the switch. Care must also be taken not to operate the switch inadvertently during manœuvres, as this may result in excessive G being applied. If the normal trimmer fails, the standby control should be used; this operates at about one-third the speed of the normal control. The aileron trimmer must not be used whilst the controls are in power, and it should be locked in the neutral position.

(i) *With power-assisted elevator fitted*

For general sustained flight the tailplane trimmer should be used in the normal manner. When manœuvring at high speeds the tailplane trimmer may be used to supplement the elevator pull force, *but this force must never be completely trimmed out.* (*See para. 72.*) Should both trimmers fail, the aircraft can be controlled throughout the speed range in power with the tailplane at the fully nose-down position. With the tailplane at the fully nose-up position, the push force required becomes excessive above 250 knots or 0.87M. The aircraft can be landed in power with the tailplane at either extreme, without undue difficulty. Normally with the controls in power the tailplane angle will be between $\frac{1}{2}°$ and 1° nose-down. The full traverse will, however, be required with the controls in manual.

(ii) *With full-power elevator fitted*

The tailplane trimmer should be used in the normal manner, the angle is usually between 1° and fully nose-down. When manœuvring at high airspeed the stick forces are light and little use of the trimmer is required. The full-power elevator tends to mask any out-of-trim forces which may be present, but the forces should always be trimmed out except when manœuvring (see para. 72 WARNING); otherwise the force may be too heavy for the pilot to hold if Manual reversion occurs inadvertently.

If both elevator trimmers fail, the aircraft can be flown throughout its speed range with the trim at full nose-down, but at full nose-up the elevator is not

sufficiently powerful to stop the nose rising at speeds in excess of approximately 420 knots. The aircraft can be landed in Power with the tailplane at either extreme without undue difficulty.

(c) *Airbrake*

(i) The airbrake may be used throughout the speed range, with undercarriage up. The trim changes are as follows.

(ii) Selection of airbrake causes moderate buffeting and a momentary nose-down change of trim which reverts to a moderate nose-up trim change when fully extended. Correcting the out-of-trim forces at high I.A.S. may lead to over-controlling.

(d) *Flaps*

(i) *At high mach number*

As speed is increased from 0.9M to 0.93M a marked nose-down trim change occurs; lowering flap also produces a marked nose-down change of trim, the degree of out of trim increasing with the amount of flap selected and with speed. At speeds above 0.92M elevator and tailplane effectiveness decreases. Pilots will realize therefore that if 0.9M is exceeded with flap lowered, or flap is lowered inadvertently at speeds in excess of 0.9M, longitudinal control will be very substantially reduced and in the worst condition may be lost completely. If control is lost with any degree of flap lowered the flap should be raised immediately.

(ii) *At high airspeed*

If speed is increased inadvertently beyond 350 knots with flaps extended, the increasing airloads decrease the flap angle which results in a nose-up change of trim.

(e) *Changes of trim*

Increase of power	Nil.
Operation of undercarriage	Negligible except when ailerons are in manual (see para. 84).
Flap down	Strong nose-down above 200 knots.
Airbrake	*High* I.A.S. slight transient nose-down, then slight nose-up. Above 0.98M slight nose-up. *At low* I.A.S. negligible.

(f) *Flying at forward C. of G.*
In the forward C. of G. condition (i.e. when ammunition is carried) the nosewheel and aircraft unstick speeds are increased from approx. 120 knots to 125 knots and 150 knots to 155 knots respectively. The stick forces required to manœuvre the aircraft in the pitching plane are slightly increased at forward C. of G. because slightly larger elevator deflections are required. At very high I.A.S. and mach no. when jack stalling occurs the amount of G it is possible to obtain is reduced.

(g) *Flying in turbulent conditions*
The recommended speeds for flight in turbulent conditions are as follows:—

Condition	*Altitude*	*Speed*
Climbing or level flight	Above 25,000 ft.	0.83M
	Below 25,000 ft.	350 knots
Descending (airbrake out, flap 20°)	Above 35,000 ft.	0.83M
	Below 35,000 ft.	280 knots

(h) *Flying with drop tanks on inboard pylons*
(i) At speeds below the permitted maximum the handling characteristics are similar to those for the clean aircraft. During combat manœuvres with fuel in the tanks it is recommended that aileron movement is restricted to half of full movement to avoid an excessive rate of roll.

(ii) *Practice Manual flying*
Practice selection of flying controls to Manual should not be made when carrying drop tanks, because the presence of such stores increases the difficulty of re-selecting Power.

(j) *Flying for endurance*
The recommended speed is 180 knots.

68. Flying at reduced speed

(a) Fly at 180–200 knots using 23° flap (2 notches down).
(b) The hood may be opened fully below 200 knots but at about 150 knots excessive vibration sets in. This vibration is reduced if the hood is closed to the halfway position, i.e. about level with the pilot's shoulders. In this position the noise level is high and rather distracting but landings can be made without undue inconvenience.
(c) Lateral rocking may occur between 200–250 knots with the flaps fully down. If the rocking becomes excessive the flaps should be raised. Any lateral rocking which occurs below 200 knots is easily controlled with the ailerons.

69. Stalling

NOTE.—Because the rate of descent is very high and because it is possible to induce an inadvertent spin when the aircraft is fully stalled, stalling practice is not to be continued beyond the buffet stage nor below 25,000 ft. R.p.m. should not be allowed to fall below 5,000.

(a) Buffet speeds at 25,000 ft., throttle fully closed, are:—

(i) *Full ammunition and 260 gallons fuel remaining*

(*Max. landing weight approx.*)

Undercarriage and flap up	... ...	140 knots
Undercarriage down and flap up	...	140 knots
Undercarriage down and full flap	...	130 knots

(ii) *No ammunition and 100 gallons fuel*

(*Normal landing weight*)

Undercarriage and flap up	... ...	135 knots
Undercarriage down and flap up	...	135 knots
Undercarriage and full flap	... ...	125 knots

(b) Above 30,000 ft. buffet occurs at approximately 140–145 knots, with the throttle fully closed, undercarriage and flap up.

(c) Use of the airbrake increases the buffet but does not affect the stalling speeds or other characteristics.

(d) Under typical approach conditions, the buffet speeds quoted above are not appreciably affected, but the height lost during recovery is reduced.

(e) (i) Although the aircraft must not be deliberately fully stalled in flight, the characteristics are described here to assist pilots who inadvertently enter the fully stalled condition.

(ii) If the control column is held back after the buffet stage is reached, a nose-up change of trim will occur, and though it will vary in degree from aircraft to aircraft, to counteract it may require full forward stick movement. Either wing way tend to drop but can be controlled by the ailerons. Relaxation of the forward pressure on the control column at this point will lead to a further reduction in forward speed accompanied by a very high rate of descent. In this condition the elevator is relatively ineffective and response is slow.

(iii) A spin or spiral may develop, and in any case considerable height will be lost. Large deflections of the ailerons near the stall will cause the aircraft to yaw in the direction of the downgoing aileron and will increase the possibility of a spin or spiral developing.

70. **High speed stalling**

(a) (i) High speed stalling is subject to the overriding restriction of para. 55 (c) whereby pilots must not exceed +7G.

(ii) At airspeeds above 0.9M between 10,000 and 30,000 feet an accelerometer reading of +4G must not be exceeded. At airspeeds below 0.9M in that height band, G must not be applied beyond the buffet stage.

(b) *Pitch-up*

(i) During turns and pull-outs adequate stall warning is given by buffeting at all heights. If the backward pressure is continued inadvertently after the stall warning, a momentary pitch-up and sudden increase in G may occur.

(ii) Below 10,000 ft. the maximum allowable acceleration of +7G accelerometer reading may be applied at the higher Mach numbers without G stalling the aircraft; no pitch-up is therefore experienced.

(iii) Between 10,000 and 30,000 ft. above 0.9M the pitch-up, if experienced, may be co-incident with the buffeting and be severe enough to exceed +7G, and it is for this reason that the restriction of +4G accelerometer reading is imposed.

(iv) Above 30,000 ft. it is not possible to achieve high accelerometer readings.

(c) *With full-power elevator*

NOTE.—The information contained in (a) and (b) above also applies to aircraft fitted with full power elevator, and the following information should be regarded as supplementary.

Buffeting and/or limiting G can be obtained with very little effort, particularly when ammunition is not carried, but if jack stalling occurs it limits the amount of G it is possible to obtain. If the stick is held hard on the restriction stop an increase in G must be anticipated if speed is reduced, because the jack unstalls and further stick movement becomes possible as speed decreases. The increase in G will be sudden if the jack unstalling is coincidental with the nose-up change of trim as speed falls through 0.95M. When manœuvring at high I.A.S. near the ground, sufficient height must be allowed for a recovery to be effected in the jack-stalled condition using the V.I. tailplane. Care should be taken when manœuvring at high mach numbers, as it is easy to pull into the pitch-up inadvertently due to the light stick force.

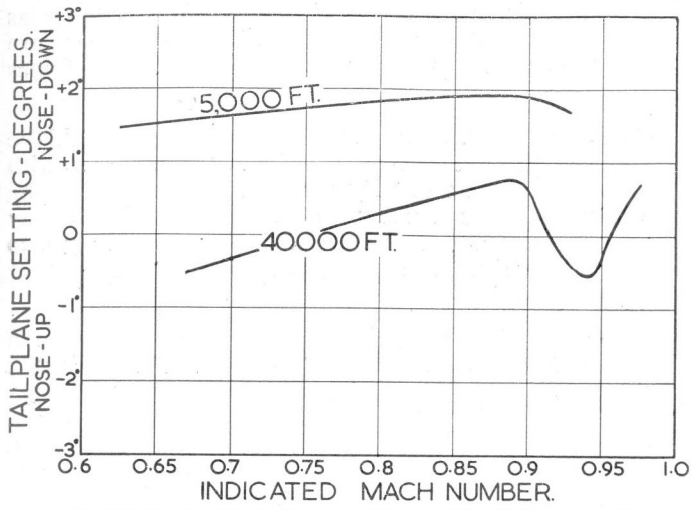
71. **Flying at high I.A.S.**

(a) When flying at high indicated airspeed all control movements must be smooth and progressive, particularly when flying at aft C.G. and/or in turbulent air. The tailplane trimmer must be used very carefully at high I.A.S.

(b) The maximum rate of roll increases with I.A.S. up to 420 knots; at higher speeds however the rate of roll progressively decreases due to jack-stalling. Normally maximum rate of roll is not required.

72. **Flying at high mach number (with power-assisted elevator)**

(a) *General.* The maximum speed in level flight at full throttle is 0.93 to 0.95M. From 40,000 feet and above the aircraft will exceed sonic speed in a 30° to 40° dive at full throttle. Transonic dives must not be started below 25,000 feet.



TYPICAL TAILPLANE ANGLES TO TRIM.
(AT FORWARD C.G.)

NOTE.—Tailplane settings are in degrees nose-down.

(b) *Trim changes.* From the diagram it can be seen that as speed increases to about 0.90M there is a progressive nose-up change of trim. Between 0.90M and 0.96M a nose-down trim change followed by a nose-up trim change occurs, the aircraft being almost back in trim again by 0.96M. At higher speeds as the aircraft becomes supersonic the trim again changes to slight nose-down.

(c) *Changes in stick force, and tailplane and elevator effectiveness*

(i) As the Mach No. is increased beyond 0.92 the tailplane and elevator become less effective. This is particularly evident at transonic speeds when even large elevator deflections have a delayed and reduced response. The tailplane may be used to assist recovery from high speed dives but the elevator pull force must never be completely trimmed out. (See para. (f) and warning.)

(ii) Since the effectiveness of the elevator decreases as mach number increases, greater deflections are required to manœuvre; consequently the stick forces increase.

(d) *Transonic flights.* Practice transonic flights should be made by putting the aircraft into a 30° to 40° dive with the tailplane trim set at $1\frac{1}{2}$° nose-down. At 0.98M as the aircraft becomes supersonic the control column may move forward about one to two inches, there may also be some rudder movement, but this does not affect directional trim.

(e) *Recovery.* To recover, close the throttle, pull maximum elevator force and retrim to $\frac{1}{2}$° nose-down. The aircraft will recover from the dive slowly, and as the nose comes up to the horizon retrim the tailplane to 1° nose-down. Recoveries can be made without using tailplane trimmer, but if the dive has been entered with full nose-down trim set, it will be necessary to retrim. Recovery must not be effected by use of the tailplane trimmer alone. The airbrake may be used during recovery; its extension causes moderate buffeting and a slight nose-up change of trim above 1.0M. It is not very effective in reducing speed.

(f) *Cumulative effect of changes in trim, tailplane and elevator effectiveness, and stick forces.* As speed becomes subsonic and falls to 0.97M, it is necessary to ease forward on the control column to avoid an increase in G. This is because of the trim changing to nose-up, the tailplane and elevator effectiveness increasing and the stick forces decreasing quite suddenly. This is also the case as speed falls through 0.9M, where the change of trim is more marked.

WARNING.—It is for the reasons given in sub. para. (f) that, when G is being applied at high mach numbers during turns and dive recoveries, great care must be taken to ensure that the stick force is never completely trimmed-out, otherwise an unexpected increase in G may result before retrimming can be effected. *This is particularly important below 10,000 feet when manoeuvring near limiting G and/or "blackout threshold."*

73. **Flying at high mach number (with full-power elevator)**

(a) All the information and recommendations given in para. 72 except the reference to stick forces also apply to aircraft with the full-power elevator. The following information should be regarded as supplementary.

(b) As the aircraft becomes supersonic there is no forward movement of the control column. Recovery from transonic dives can be made without using the tailplane trim. When jack stalling occurs, retrimming nose-up will decrease the angle between the elevator and tailplane and unstall the jack, enabling further stick movement to be applied. Normally the tailplane should not be trimmed back beyond $\frac{1}{2}$° nose-down: this is to prevent a sudden increase in G caused by the nose-up trim change and the increasing effectiveness of the tailplane and elevator.

(c) *When carrying stores*

The handling characteristics differ very little from a clean aircraft. The rate of acceleration in level flight is decreased and at high mach number the aileron jack may stall, restricting stick movement and manœuvre in the rolling plane; the restriction disappears as soon as mach number is decreased.

74. **Aerobatics**

(a) Until experience is gained, the following speeds, in knots, are recommended:—

Roll	350
Loop	425
Roll off	450
Vertical roll	500

(b) It is recommended that until experience is gained, loops are started in the height band 10,000 ft. to 15,000 ft.

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75. **Spinning**

NOTE.—1. No inverted spinning tests have been carried out; information in this paragraph about inverted spinning is based on experience with similar types of aircraft.

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NOTE.—2. If a spin occurs with undercarriage and flaps down raise them immediately. If normal recovery action fails, jettison external stores, if carried, before emergency recovery is attempted. Because of the cranked stick pilots should familiarise themselves with its position corresponding to neutral aileron. The control column when aligned with a white circle on the instrument panel adjacent to the A.S.I. indicates the neutral aileron position.

(a) Intentional spinning is prohibited. The following information applies to aircraft with or without extended wing leading edges and is provided to acquaint pilots with the spin characteristics and recovery actions in case the aircraft is spun inadvertently. Spins may be entered inadvertently from harshly executed manœuvres if aileron and/or rudder are applied in the presence of buffet. A normal spin will usually result. An inverted spin is only likely to result from manœuvres such as a loop or roll off the top when the speed on the top has become too low; thus the likelihood increases at high altitude. It is recommended that the above spin-prone conditions be avoided.

(b) (i) When a normal spin occurs the nose may rise and the aircraft may roll on to its side or back, hesitating before entering the spin. Generally a spin to port gives a regular rotation in a 60° nose-down attitude, whereas a spin to starboard is erratic with hesitant and irregular rolling, pitching and yawing. When spinning in either direction the ailerons should be held neutral as out-spin aileron may make recovery impossible. Note that there is an instinctive tendency to oppose the spin with aileron unless a conscious effort is made to hold the aileron neutral.

(ii) When an inverted spin occurs, the aircraft rolls in the opposite direction to the turn.

(c) Bear in mind the manœuvre from which the spin has been entered, and *always* refer to the turn indicator to decide the direction of spin and not to external references. Carry out the following recovery actions:—

(d) *Normal spin*

(i) *Normal recovery*

1. Apply *full rudder* opposing the direction of the turn.
2. Move the control column *fully forward*, making sure the ailerons are neutral.
3. Maintain recovery action.
4. Centralise the rudder immediately rotation ceases.
5. Ease out of the ensuing dive.

(ii) *Emergency recovery*

If *after two turns* recovery action is unsuccessful, the following method is recommended.

1. *Maintain* full rudder opposing the turn and control column fully forward.
2. Move the control column in the same direction as the turn needle.
3. Maintain recovery action and be ready to centralise rudder and ailerons immediately the spin ceases in order to prevent an inadvertent spin in the opposite direction.
4. Ease out of the ensuing dive.
5. If recovery has not been effected by 10,000 feet, jettison the hood and prepare to abandon the aircraft if the spin persists.

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(e) *Inverted spin*

(i) *Normal recovery*

1. Apply *full rudder* opposing the direction of the turn.
2. Move the control column *fully back* making sure the ailerons are neutral.
3. Maintain recovery action.
4. Centralise the rudder immediately rotation ceases.
5. Ease out of the ensuing dive.

(ii) *Emergency recovery*

If, *after two turns*, recovery is unsuccessful the following method is recommended.

1. *Maintain* full rudder opposing the turn and control column back.
2. Move the control column in the opposite direction to the turn needle.
3. Maintain recovery action and be ready to centralise the rudder and ailerons immediately the spin ceases in order to prevent an inadvertent spin in the opposite direction.
4. Ease out of the ensuing dive.
5. If recovery has not been effected by 10,000 feet, jettison the hood and prepare to abandon the aircraft if the spin persists.

CIRCUIT PROCEDURE AND LANDING

76. Circuit procedure

NOTE.—460 lb. (60 gallons) of fuel should be allowed for the circuit and landing. (But see para. 56 (d).)

(a) *Circuit speed*

7,000 r.p.m. and 38° flap (4 notches) give a comfortable speed of 170/180 knots. To reduce speed for joining the circuit, flap, within the limitations, can be used successfully to augment the airbrake. Do not select more than one hydraulic service at a time and allow the cycle of each hydraulic operation to be completed before the next service is operated. The undercarriage should only be selected down when the wings are laterally level.

(b) *Checks before landing*

Airbrake	IN, indicator black
Undercarriage	DOWN below 230 knots Three green lights
Brakes	Pressure, operation, OFF Main supply 2,850 ±150 lb./sq. in. At each wheel 1,500 lb./sq. in.
Flaps	As required Fully down on finals
Fuel	Contents Booster-pumps ON (AUTO or MANL on unmodified aircraft)
Harness	Tight and locked

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NOTE.—The brake lever should be held on for 2–3 seconds. If the system is serviceable both brake needles should remain at maximum pressure. If a hydraulic pipe is fractured a lower than normal pressure will be indicated initially and this will decrease at a rate depending on the size of the fracture. The check should not be repeated because at each operation hydraulic oil will be lost.

(c) *Final approach*

(i) Turn across wind at 160 knots aiming to lower full flap on the final stages. Steep approaches are not recommended.

(ii) To ensure immediate engine response maintain at least 5,000 r.p.m. until finally committed to a landing. Under conditions of high wind or gustiness it is more comfortable if the speeds below are increased by 5 knots.

(iii) The recommended speeds, in knots, at the runway threshold:—

At normal landing weight

No ammunition, 800 lb. (105 gallons) or less fuel remaining 130

At maximum landing weight

No ammunition, 2,300 lb. (300 gallons) fuel remaining 135
Full ammunition, 1,600 lb. (210 gallons) fuel remaining 135

77. Landing

(a) As the touch-down point is approached the rate of descent should be checked and the aircraft flown gently on to the ground at about 5–10 knots less than the runway threshold speeds. Holding off may result in an excessive nose-up attitude with the subsequent danger of touching the tail cone and/or dropping a wing. If the latter occurs, corrective aileron may be effective in raising the wing, but will cause the aircraft to yaw markedly in the direction of the down-going wing. The nosewheel can be held off at speeds down to 70 knots, but the shortest run is achieved by putting the nosewheel firmly on to the runway and applying the brakes.

(b) *When carrying stores*

Enter the threshold at 140 knots and fly the aircraft on to the ground at 130 knots.

(c) *Braking*

NOTE.—The effectiveness of the braking system is greatly decreased on very wet or icy runways. If wind conditions are favourable it may be advantageous to use aerodynamic braking.

When the nosewheel has been lowered on to the runway the brakes can be used continuously and the maxaret units will prevent wheel locking; however, to prolong the efficiency and life of the brakes, braking should be judicious according to length of landing run available. The landing can be cut to less than half normal by using continuous full brake once the aircraft is firmly on the ground, but this procedure causes rapid brake and tyre

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wear and should not normally be used. The aircraft must be firmly on the ground before applying the brakes. If it is allowed to touch down with the brakes on, the maxaret units will not operate and the wheels will lock; however, if once having started turning, the wheels should stop because of a skid or bounce, they will not lock unless the skid or bounce continues for more than 4 seconds. After a landing involving heavy braking, ten minutes should elapse before the next landing. If the intervening period of taxying has also required prolonged use of the brakes, twenty minutes should elapse before the next landing. Observe the same precautions in brake tests.

(d) *Crosswind landing*

For cross-wind landings the "crab" technique should be used. In light winds no difficulty should be experienced in touching down, but in strong crosswinds full rudder may be required to correct the crabbing. The rudder has a delayed reaction which will require anticipation. The effect of full rudder is to produce a marked roll which must be counteracted with aileron. When the crabbing has been corrected the aircraft should be flown gently on to the ground and the nosewheel lowered on immediately to decrease the angle of attack of the wings and thus reduce the tendency for the cross-wind to lift the into-wind wing. Care should be taken to centralize the rudder before applying the brake. If the crosswind is gusting strongly the approach speed should be increased by 5 knots.

78. Instrument approach

The following are the recommended airspeed, power and flap settings for an instrument approach with the undercarriage lowered:—

	R.P.M.	Flaps	Airspeed (knots)
Down-wind	7,000	40°	170/180
Base leg	7,000	40°	170/180
Glide path	7,000	Full	150/160

79. Going round again

Open the throttle smoothly to the power required, raise the undercarriage, and at a safe height raise the flaps and retrim as necessary.

80. **Checks after landing**

Brake pressure	Sufficient
Flaps	Up
Cockpit pressure	Off
Camera master switch	Off
Pressure head heater	Off
Both booster-pumps	OFF

81. **Stopping the engine**

Set the tailplane to 0°. Close the throttle.
When the r.p.m. have stabilized at 3,000 to 3,200, turn off the H.P. cock, then check:—

All electrics	Off
Battery master switch	Switch off
Hood clutch selector	FREE
L.P. cock	~~OFF when engine stops rotating~~ LEAVE ON A.L.1
Ejection seat	Replace the safety pin before leaving the cockpit.

FLYING IN MANUAL

82. **Selecting Manual**

(a) (i) It is structurally safe to fly in Manual within the speed limitations of para. 55(b) and in emergency, Manual could be selected at any altitude and airspeed. However, until experience is gained, it is recommended that selection of Manual and subsequent practice flying in Manual should be carried out above 10,000 feet. This is because of the out of trim forces which may be present when Manual is selected and the extreme heaviness of the controls and lack of manoeuvrability when in Manual.

(ii) Before selecting Manual, ensure:—

Airspeed	250 knots or 0.80M if above 40,000 ft.
Tailplane	In trim
Aileron and rudder trim indicators	Neutral
Aileron trim lock	Disengaged

(b) *With full-power elevator*

The elevator forces are slightly higher on aircraft fitted with the full-power elevator because of the additional force required to overcome the feel spring. Provided that the aircraft is in trim in Power, the trim changes on selection of Manual are usually slight. If the tailplane and elevator are incorrectly rigged, however, these changes may be large. Because of this possibility, when practice flying in Manual is to be carried out, the first selection to Manual should be made above 10,000 feet and at a low airspeed.

83. **Flying in Manual**

(a) The elevator forces are high but tolerable and no difficulty should be experienced with longitudinal control. The ailerons are heavy and require considerable effort to produce only small deflections. Reaction of the aircraft to aileron deflection is slow and delayed, therefore all necessary aileron movements must be anticipated. The rudder, the further effect of which is marked, can be used to assist control in the rolling plane but should be used with care at low airspeeds.

(b) *When carrying stores*

Because of the increased inertia, lateral control is less effective; this is particularly noticeable on the approach when lateral rocking due to either turbulence or overcontrolling is difficult to damp out. In gusty or severe crosswind conditions consideration should be given to jettisoning the stores before attempting to land. Due to the increased turbulence below the wing and the tendency of the ailerons to up-float the likelihood of obtaining a false anchorage when reverting from Manual to Power is increased. SHOULD EITHER INBOARD TANK FAIL TO FEED, THE TANKS MUST BE JETTISONED IF A MANUAL LANDING IS TO BE MADE. A.L.1

(c) *Effect of asymmetric fuel flow*

(i) If Manual control is selected at 250 knots when one wing tank is empty and the other full, a maximum single-handed force will be required to restrain the wing-low tendency. The amount of trim to counteract this tendency varies with I.A.S., little being needed at high speed but maximum at approx. 190 knots. If speed is gradually reduced below 190 knots

an increasing stick force, up to a maximum of 8 lb. is required to maintain wings level. This asymmetric load condition is likely to cause false anchorages on reversion to Power. Before reselecting Power the aircraft should be trimmed hands off at 250 knots. When a correct reversion to Power is achieved the aileron trim should be set to neutral, otherwise, if an inadvertent reversion to Manual occurs, or if Manual is again selected at a later stage of the flight when the second wing tank has emptied, the previously applied trim will produce a wing-low tendency, the severity depending on the amount of trim applied and the I.A.S.

(ii) With one empty and one full drop tank, i.e., one tank fails to transfer, control in Manual on the approach is not possible. In these circumstances both tanks should be jettisoned (airspeed 250–300 knots).

(d) *Trim changes*

Increase and decrease power	Nil.
Operation of undercarriage	Roll in either direction (depending on which main leg lowers first) see para. 84.
Flaps down	Strong nose–down especially above 200 knots.
Flaps up	Strong nose–up especially above 200 knots.

84. Landing in Manual

(a) Until pilots have considerable experience of flying in Manual control, practice landings should be made only in ideal conditions, i.e. a steady wind down the runway. Because any asymmetric lowering of the undercarriage is liable to cause lateral control difficulties, the undercarriage must be lowered at a safe height. A wider than normal circuit should be made, followed by a long straight powered approach. When the airspeed is below 150 knots with undercarriage and full flap down, appreciable aileron buffet can be felt on the control column. If an overshoot has to be made, the undercarriage should not be raised until a safe height is reached. Flaps must only be selected up to a mid-position because of a nose-up change of trim, full retraction being deferred to a safe height.

(b) *With external stores* (See also para. 83 (b))
If the drop tanks are full or partly full they must be jettisoned before landing. Landing with any asymmetric loading other than one empty inboard drop tank must not be attempted. Trials have shown that with a nominal 1,000 lb. weight on an inboard pylon the wings cannot be held laterally level at speeds below 180 knots.

85. Reselecting Power

Before reselecting aileron and/or elevator power, the aircraft must be trimmed, laterally and longitudinally, in straight and level flight at the same airspeed and approximate altitude as when Manual was selected. Immediate re-engagement is more likely on the elevator than on the ailerons; it is therefore preferable to reselect elevator before ailerons. After reselection check that the appropriate magnetic indicators are black.

86. Clearing false anchorages (ailerons)

(a) If power is reselected below 10,000 ft. and a false anchorage occurs, *immediately* switch Power OFF and either

(i) Return to base and land in Manual, or

(ii) Climb above 10,000 ft. before making any further attempt to re-engage Power.

(b) If Power is reselected above 10,000 ft. and a false anchorage occurs, it may be cleared as follows:—

(i) *One-way restriction*

The control column should be moved rapidly over its full movement in the direction of unrestricted travel. If the airspeed is below 250 knots, this can be done without producing excessive aircraft roll.

(ii) *Both-ways restriction*

Lower full flap at an airspeed of 250 knots, and select aileron Power ON (or hold switch in Power if Mod. 452 is incorporated). The aileron buffet which occurs in this configuration will probably be sufficient to enable the pawls to engage in the slots, but if necessary move the control column laterally until the magnetic indicator turns black.

WARNING.—1. If it is not possible to clear a false anchorage, select Power OFF. Return to base and land in Manual.

2. If, when Manual is selected following a false anchorage, the controls remain jammed (indicating that Manual reselection is impossible) the aircraft must be abandoned.

PART IV

EMERGENCY HANDLING

87. Action in the event of fire

(a) If the engine fire warning light comes on, the throttle should be closed immediately. If the light then goes out within 5 seconds, a hot gas leakage as distinct from a fire is indicated. It is safe to use the engine in this condition, but a landing should be made as soon as practicable. Reduced power should be used, but unless the power required is small the light will probably come on again. It is advisable, therefore, to throttle back every 5 minutes to check the light goes out in order to ensure that a fire has not started.

(b) Should the light remain on after throttling back, a fire is indicated. Should a fire occur; set:—

H.P. cock	OFF
L.P. cock	OFF
Booster-pumps	OFF

and quickly reduce airspeed to a practicable minimum. Then press the extinguisher pushbutton. Should the light remain on and the fire persist, the aircraft should be abandoned.

(c) If a satisfactory extinction has occurred the warning light should go out as the circuit is broken by the cooling of the flame switches. *The engine must not be restarted*, due to the risk of fire with the fire-fighting resources exhausted.

(d) Carry out forced landing procedure (see para. 92), or abandon.

88. Electrical system failures

(a) *Single generator failure*
If either generator fails, the output of the other is sufficient for non-combat flying provided that all non-essential electrical services are off.

(b) *Double generator failure*
If both generators fail, all electrical services will be supplied by the batteries. These, if fully charged, will maintain the following output before they fail (i.e., battery voltage below 16 volts).

Output—Amps. ..	150	125	100	75	50	38	25
Time—mins. ..	1½	2	3	5	10	18	40

NOTE.—When 2 24-volt batteries are fitted these times should be doubled.

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To assist the pilot in deciding which loads should be shed, if generator failure occurs, the following table lists the major services and the current they require.

Service	Load (amps.)	Service	Load (amps.)
Booster pumps ..	35	Pressure head heater ..	6
Radar ranging ..	30	Starter control (relighting)	6
A.C. inverters ..	15	Fuel contents gauge ..	4.5
Tailplane actuator ..	12	G.G.S.	4
Hood control	10	G.G.S retraction ..	3.5
VHF sets	7.5	*All other* electrics ..	10
IFF set	6.5		
D.M.E.	6	Maximum flight load	156

NOTE.—The average flight load is 105 amps.

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(c) *Double generator and battery failure*

Once the batteries are discharged, no electrical services may be operated, e.g. trim tab actuators, tailplane motors, electro-hydaulic selectors, etc. If the flying controls are in Power, selection of Manual will not be possible unless Mod. 502 has been embodied, in which case Manual may be selected by pushing the emergency selector buttons. In addition the fuel gauges, Mk. 4F compass and electrically-operated flight instruments will become unserviceable. The fuel booster pumps will cease operation, which may entail reduction in altitude and engine r.p.m. to ensure satisfactory engine running. (See para. 56 (f) (ii).) No relight facilities will be available when the batteries are fully discharged.

(d) *Action in the event of double generator failure*

(i) If complete generator failure occurs, switch off all non-essential electrical services to conserve the battery for as long as possible.

(ii) Set the tailplane angle to zero incidence. (See Note 2 below.)

(iii) Provided that the engine is running correctly and hydraulic pressure is normal the flying controls may be left in Power. The magnetic indicators will show white when the batteries are discharged although the controls will remain in Power.

NOTE.—1. If any doubt as to the serviceability of the hydraulic system exists, select Power OFF before the batteries are discharged, unless mod. 502 is incorporated.

2. If it is necessary to descend more rapidly than at normal gliding speed, 15° flap may be used to increase the rate of descent, but the speed must not exceed 0.9 M and the tailplane incidence must be left at zero. Intermediate degrees of flap can only be selected if electric power is available. The pull force needed to reduce speed to 210 knots will be considerable in Manual.

(e) *Emergency operation of the tailplane*
If the normal tailplane motor fails or "runs away", lift the cover of the standby switch on the port shelf and use that control. Rate of operation of the latter is about one-third that of the normal control. If complete electric failure occurs, control of the tailplane is impossible. It is important therefore to set the tailplane to zero incidence before the batteries are fully discharged.

(f) *Aileron trim malfunction in Manual*

(i) When flying in Manual, should the aileron trim actuator malfunction resulting in full trim being applied with subsequent inability to rectify, carry out the following actions:—

Reduce speed below 200 knots.
Select elevator power ON.
If above 5,000 ft. select aileron power ON; if below 5,000 ft. leave ailerons in Manual (but see (iii) below).
Land as soon as possible.

(ii) If a one-way restriction occurs when reselecting aileron power clear it in the normal way. If a both-ways restriction occurs reselect Manual immediately and remain in Manual.

(iii) A landing in Manual with full aileron trim applied will be hazardous and should only be attempted if conditions are favourable.

89. Hydraulic system failures

(a) *Complete hydraulic failure*

(i) Periodic checks of the triple pressure gauge should be made in flight and the central needle should normally read 3,000 ± 150 lb./sq. in. If the reading drops substantially below this figure when no service is being operated, then hydraulic failure should be suspected. The red warning light, and the audio warning when Mod. 327 is fitted should come on if the pressure falls below 600 lb./sq. in.

(ii) If the hydraulic supply pressure fails, there may be sufficient reserve in the power controls accumulators for a maximum of 3½ full reversals of aileron and elevator, the actual reserve depending on the state of charge of the respective accumulators at the time of failure. However, even if no control movement is made, accumulator pressure will not be maintained for a long period, due to normal hydraulic component seepage. When the accumulators are exhausted the controls will revert automatically to Manual.

(iii) A failure in the power controls hydraulic circuit, as distinct from supply failure, may lead to immediate and automatic Manual reversion when the pressure at the locking pawls has fallen well below that at which the warning light becomes illuminated.

(iv) The wheel brakes accumulators provide sufficient pressure for brake operation during landing down to an accumulator pressure reading of 750 lb./sq. in. approximately.

(b) *Action in the event of complete hydraulic failure*

(i) Complete failure will be indicated by a loss of pressure on the gauge followed by the red light coming on and, when Mod. 327 is incorporated, by the audio warning.

(ii) Immediate action should be:—

(1) Reduce speed to 250 knots, or if above 40,000 ft. 0.80M.

(2) Release the aileron trim safety lock and check that the trim indicator shows zero.

(3) The controls may be left in Power, provided electrical supply is normal,* but when Manual reversion occurs, and in any case at a safe height before joining the circuit switch OFF elevator and aileron Power.

* OR MOD 502 IS INCORPORATED. A.L.1

(iii) Lower undercarriage and flaps on the emergency systems.

(c) *Partial hydraulic failure*

Partial hydraulic failure can occur due to a type of leak which could cause complete loss of pressure during the operation of a service, but which would allow pressure to build up again when the operation is complete. This type of failure can cause the power controls to disengage temporarily and re-engage with the possibility of a false anchorage.

(d) *Action in the event of partial hydraulic failure*

(i) Reduce speed to 250 knots or 0.80M.

(ii) Release aileron trim safety lock and check that trim indicator shows zero.

(iii) The controls may be left in Power to assist in manœuvring, provided electrical supply is normal, but should a false anchorage occur and in any case before landing, switch OFF elevator and aileron Power.

(iv) If a partial hydraulic failure occurs subsequent to complete electric failure when the controls are still in Power, the landing is likely to be extremely hazardous, and it is recommended that the aircraft be abandoned.

* & MOD. 502 IS NOT INCORPORATED. A.L.1.

90. **Engine failure and flame-out**

(a) *Engine seizure*

Engine seizure will involve both hydraulic and electric supply failure. If the engine has failed due to obvious mechanical causes do not attempt to relight. Proceed as follows:—

(i) Close the throttle. Turn off the H.P. and L.P. cocks and switch off the booster-pumps.

(ii) Reduce speed and glide at 210 knots.

(iii) Switch of all unnecessary electrics.

(iv) Set tailplane incidence to zero. Release aileron trim safety lock and check that trim indicator is at zero.

(v) The controls may be left in Power, but manual reversion must be expected. (SEE PARA. 88 (d) NOTE 2) A.L.1.

(vi) Carry out forced landing procedure (see para. 92) or abandon.

(b) *Flame-out*

(i) If a flame-out occurs a relight may be attempted *immediately*, while r.p.m. are decreasing, by pressing the relight button with the H.P. cock open and the throttle at its set position. A successful relight will be indicated by the r.p.m. stabilizing and then commencing to rise: the likelihood of a successful relight is increased if the height and airspeed are below the recommended maxima for relighting.

(ii) If no relight occurs within 10 seconds, release the relight button and proceed as follows:—

H.P. cock	OFF.
Throttle	Closed.
L.P. cock	Leave on.
All non-essential electrical services	OFF (see para. 88(b)).
If below 30,000 ft.	Relight at once.
If above 30,000 ft.	Switch off the booster pumps, descend to 30,000 ft. and carry out the relight drill.

(iii) If above 30,000 ft. the decision either to descend quickly or glide at 210 knots will depend on the prevailing circumstances, e.g., weather conditions, distance to travel, etc. The following should be borne in mind.

1. The likelihood of obtaining a relight increases with decrease in altitude.

2. At best gliding speed the aircraft will cover approximately $2\frac{1}{2}$ miles per 1,000 ft.

3. With normal services running, the battery cannot be relied on for more than approx. 5 minutes. All non-essential services, including booster-pumps, should therefore be switched off to conserve battery power.
4. Unless mod. 502 is embodied Manual should be selected before attempting to relight, in case relighting is unsuccessful and the batteries are weakened to the extent that it will not be possible to select Manual.
5. Descending rapidly at a speed above 210 knots will increase windmilling r.p.m. Consequently hydraulic pressure will be higher and the generators may continue to supply power. (See also para. 88(d) Note 2.)
6. If a glide is to be made at 210 knots the tailplane should be set to Zero.

91. **Relighting**

NOTE.—Relights are obtained more easily at lower altitudes and with lower airspeeds. Every precaution should be taken to ensure success at the first attempt due to the loads on the battery. If the engine and its fuel system are serviceable and the drill is followed correctly, a relight should occur at the first attempt.

(i) Check and/or set:—

Maximum altitude	30,000 ft.
Maximum airspeed	To give 1,200 to 2,500 windmilling r.p.m.
All non-essential electrics	OFF (see para. 88(b)).
Throttle	Closed.
Battery master switch	ON.
Ignition switch	ON.
Starter master switch	ON.
Booster-pumps	ON or AUTO.

(ii) Press the relight button and at the same time open the H.P. cock fully, keeping the relight button pressed until the engine lights up and r.p.m. rise by about 200. R.p.m. should commence to rise almost immediately. The initial rise in j.p.t. may be small. When the r.p.m. rise to idling, increase power carefully.

(iii) If no relight occurs within 15 seconds, release the relight button, close the H.P. cock, switch off the booster-pumps. Allow, if possible, 30 seconds for the engine to dry out before the next attempt.

(c) *Emergency relighting*

(i) In circumstances where the engine cannot be relit by use of the above drill, *provided that the pilot is reasonably certain that the fault lies in the relight button circuit*, it may be possible to obtain a light-up using the starter pushbutton in the following way:—

(ii) To ensure that a live cartridge is not fired, the spent cartridge with which the engine was ground-started should first be mechanically reindexed. To do this, set the starter master switch OFF and then press the starter pushbutton fully in and allow the button to spring fully out again.

(iii) Check and/or set:—

Maximum altitude	15,000 ft.
Maximum airspeed	To give 1,200-2,500 windmilling r.p.m.
All non-essential electrics	OFF (see para. 88(b)).
Throttle	Closed.
Battery master switch	ON.
Booster-pumps	ON or AUTO.
Starter master switch	ON.
Ignition switch	ON.

(iv) Press the starter pushbutton again and then open the H.P. cock fully. The igniters will then function but if the reindexing drill has been correctly carried

out a cartridge will not be fired. If no relight occurs within 30 seconds, set the H.P. cock OFF when the starter button comes out. The spent cartridge must be reindexed as in (ii) above before any further attempt is made.

WARNING.—If for any reason the reindexing drill has not been correctly carried out and a live cartridge is indexed when the starter button is finally pressed, it is probable that damage will be caused to the starter and to the aircraft. This probability may be lessened to some extent if the engine windmilling speed is low and positive G is not applied at the time of operating the pushbutton.

(d) *Failure to relight*

(i) If the engine fails to relight turn off the H.P. and L.P. cocks and switch off all non-essential electrical services (including the booster-pumps).

(ii) Set the tailplane incidence to zero and reduce speed to the trimmed condition. (SEE PARA 88(d) NOTE 2) A.L.1.

(iii) Release the aileron trim safety lock and check that the trim indicator is at zero.

(iv) Carry out forced landing procedure (see para. 92) or abandon.

92. **Forced landing procedure**

NOTE.—All the circumstances prevailing at the time of engine, hydraulic, or electrical failure cannot be predicted. Each system and the effects of failure of each system must be thoroughly understood. The following information is intended to help the pilot reach the best decision.

(a) The following are the recommended gliding speeds for maximum range and minimum sink.

Condition	*Airspeed*	*Glide ratio*	*Approx. Rate of descent*
Max. range	210	13.6:1	1,700 f.p.m.
Min. sink	175	11.9:1	1,500 f.p.m.

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The recommended gliding speed for maximum range is 210 knots. In still air conditions a distance of approximately 86 n.m. can be achieved from 40,000 ft. or about 2 n.m./1,000 ft. The average rate of descent is approximately 2,300 ft./min. These distances do not allow for the recommended overhead height of 7,000 ft. (See 92 (f).) The gliding speed of 210 knots should be maintained when gliding for range.

(b) If a deceleration is required to obtain the correct gliding speed climb rather than use the airbrake. If used, the airbrake requires considerable hydraulic power and constitutes a hazard on landing should it remain out.

(c) Check and/or set the following:—

H.P. and L.P. cocks	OFF
Booster-pumps	OFF
Tailplane incidence	Zero (SEE PARA 88(d) NOTE 2) A.L.1
All non-essential electrics	OFF
Aileron trim	Safety lock off Indicator zero
Elevator and aileron power *	Leave on temporarily, but select OFF. (1) Before electric power fails. (2) If a false anchorage occurs.

* UNLESS MOD. 502 IS EMBODIED. A.L.1

(d) (i) Engine failure may lead to either or both electrical and hydraulic failure. Experience shows that at 200 knots windmilling r.p.m. will create sufficient hydraulic pressure for limited use of the power controls, but large or frequent use of the controls or selection of any of the services may cause Manual reversion. If pressure then rebuilds, false anchorages may occur.

(ii) *1 Selecting Power off can only be accomplished whilst electrical power is available. *To avoid the danger of obtaining a false anchorage with no electrical power available and to prevent inadvertent Manual reversion at an inconvenient stage of the approach, select Power off before electrical failure occurs.*

*1 UNLESS MOD. 502 IS EMBODIED BEFORE.

(iii)* If electrical failure occurs before Manual can be selected, to keep in Power, windmilling r.p.m. should be maintained as high as possible and control movements kept to a minimum; if a reversion to Manual then follows, reduce airspeed (not below 170 knots) to decrease windmilling r.p.m. and use the controls excessively to avoid a rebuild of pressure. In these circumstances the landing is likely to be extremely hazardous and it is recommended that the aircraft be abandoned.

(iv) If a false anchorage occurs with no electric power available it can only be cleared as described in para. 86. If for any reason this is not possible the aircraft must be abandoned.

(e) If electrical power is still available, the undercarriage and flaps may be lowered by means of the normal systems, but the services will take longer than usual to lower. If electrical power is not available, the emergency systems can be used, but the undercarriage, once locked down, cannot be retracted either in the air or on the ground in the event of overshooting, and the flaps can only be lowered to the fully-down position.

(f) (i) If a forced landing on an aerodrome is being made attempt to arrive overhead at approx. 7,000 ft. or above.

(ii) Plan a Manual approach and aim to be downwind opposite the caravan at 4,000 ft. A.G.L. or above, depending on prevailing wind conditions, at 175 knots.

(iii) Turn across wind maintaining speed at 175 knots and when it is certain the touch-down point can be reached select full flap.

(iv) Maintain 175 knots on the final approach and aim to enter the threshold at 150 knots. In Manual the pull force to round out from a glide approach is large.

NOTE.—1. Experience suggests that it is preferable to lower the undercarriage when making a forced landing on an aerodrome or in open country. In the down position it absorbs much if not all of the initial impact, assists in retarding the aircraft, and, provided that electrical

power is available and that the emergency lowering system has not been operated, it may be retracted after touch-down if necessary. With the undercarriage up, the aircraft must be lowered gently on to the ground *at the normal speed;* if the speed is too low a wing drop is likely to occur and if the speed is too high the aircraft is prone to bounce, the initial impact having a damaging effect on the cockpit.

2. With the undercarriage down the rate of descent is high and it increases rapidly as speed is reduced below 180 knots.

3. For practice forced landings, a flap setting of 30° and 5,000 r.p.m. will give a rate of descent comparable with an engine-off glide.

93. **Undercarriage and flaps emergency operation**

NOTE.—1. Both systems operate independently of their respective normal selectors.

2. When Mod. 428 is incorporated both systems are isolated from the power controls hydraulic system. Operation of either emergency system will *not* cause hydraulic fluid to be jettisoned and the flying controls will remain in Power. With Mod. 428 embodied the drills contained in (a) (ii)-(vi) and (b) no longer apply.

(a) *Undercarriage*

(i) If the undercarriage fails to lock down by normal operation when both the electric and hydraulic systems are serviceable, repeated raising and lowering and the application of side-slip or G may have the desired effect.

(ii) If all attempts to lower the undercarriage (or any unit of the undercarriage) by the normal system fail, the emergency system should be used. However, if

electrical and hydraulic power is normal and either of the undercarriage selector buttons are in, all hydraulic fluid will be jettisoned resulting in Manual reversion. The rate of jettisoning is greater if the UP button is in. Therefore depending on prevailing weather conditions the following should be borne in mind.

(iii) If conditions are favourable, i.e., good visibility and a steady wind down the runway, Manual should be selected before operating the emergency control and the landing made in Manual.

(iv) If conditions are not favourable, i.e., a strong cross-wind or if the wind is gusting, a landing in Power should be made. To prevent the loss of hydraulic fluid both undercarriage selector buttons must be set to the out position. To achieve this carry out the following procedure.

1. Select up normally to ensure that the "DOWN" selector button is out.

2. Pull out the "UP" button (this requires little effort) and *ensure that it remains out.* See (v) below.

3. Operate the emergency air selector by holding the knob in and then pulling the handle.

(v) With both selector buttons out, both solenoids in the selector valve are de-energized enabling the slide valve to adopt a neutral position. The undercarriage hydraulic lines are thus isolated from the remainder of the hydraulic system and only the fluid in the lower end of the jacks will be jettisoned. The flying controls will remain in Power and the flaps may be operated normally. *It is essential that the UP button remains out. There is a tendency for it to return to its in position. If this occurs Manual reversion will follow* in which case the power controls switches should be set to OFF. When the undercarriage up selector button is out the airbrake is isolated.

(vi) If complete electrical failure has occurred, both solenoids in the selector valve will automatically be de-energized and the slide valve will be in the neutral position when the emergency lowering system is used. Only the fluid in the lower end of the jacks is jettisoned.

(vii) To raise the undercarriage on the ground in an emergency following normal selection, rotate and press the normal UP selector button. It must not be used in this way to retract the undercarriage in the air as there is a risk of the legs being retracted when not fully extended and the leg fairings may be damaged. If the UP button cannot be pressed in normally after take-off, the wheels must be left down and the aircraft landed.

(b) *Flaps*

(i) If electrical or hydraulic supply failure has occurred the flaps may be lowered, fully down only, by pulling out the emergency lowering control after first pushing in the central knob. If the electrical supply has failed only the hydraulic fluid in the lower end of the jacks will be jettisoned when the emergency system is used.

(ii) If the electrical and hydraulic supplies are normal all fluid will be jettisoned when the emergency lowering system is used; a Manual reversion will then follow. The decision whether to make a flapless landing or a Manual landing will depend on the prevailing wind, length of runway available, and pilot experience.

(iii) If the prevailing wind is strong, the runway length is adequate, i.e. 2,000 yards and the pilot has experience of flapless landings, a flapless landing in Power should be made, particularly if the wind is across the runway or gusty. The emergency flap should be used as soon as the nosewheel is lowered on to the runway.

(iv) If there is little wind, a Manual landing should be made. Before turning downwind release the aileron trim lock and ensure that the aircraft is in trim, then set both power control switches off. Anticipate the nose-down change of trim, which will occur when emergency flap is selected, by retrimming nose-up. Pull the emergency flap selector early on the approach.

94. **Landing with an undercarriage unit not locked down**

NOTE.—Experience has shown that these techniques cause minimum damage to the aircraft and none to the pilot.

(a) *Both main wheels only locked down*

(i) Use up as much fuel as is safe in order to move the C. of G. as far aft as possible. Unless circumstances dictate otherwise land on a runway.

(ii) Check harness tight and locked.

(iii) Select hood open when crossing the threshold.

(iv) Make a powered approach at the normal speed; on touch-down turn the H.P. cock off and maintain a moderate nose-up attitude.

(v) Trim the tailplane to give full nose-up trim and as the speed falls below 100 knots maintain a high nose-up attitude without actually touching the tail cone on the ground.

(vi) When the nose drops on to the runway at approximately 80 knots use the brakes gently to keep straight.

(b) *Nosewheel and one main wheel locked down*

If all attempts to lower the undercarriage satisfactorily fail and only the nosewheel and one main wheel come down, make a normal approach and landing; on touch-down turn the H.P. cock off and hold the wings level for as long as possible by use of the ailerons. When aileron is applied and when the wing finally drops, the aircraft will swing in the direction of the unlocked wheel; this should be counteracted as much as possible by opposite brake. Experience has shown that the distance from the landing path to the point of rest averages approximately 250 yards, varying from 100 yards (min.) to 400 yards (max.). A runway should be chosen which has an area about 400 yards wide available in the direction of the anticipated swing.

(c) *Belly landing*

If it is necessary to land with the undercarriage retracted, make a normal approach and fly the aircraft gently on to the runway at the normal speed.

95. **Landing with a burst tyre**

No special difficulty is encountered when landing with a burst tyre(s), directional control and braking being adequate.

96. **Flapless landing**

A very long shallow powered approach should be made and the boundary crossed at the normal speed. Even when the throttle is closed, speed decreases very slowly; the aircraft should therefore be placed firmly on to the runway as soon as possible, the nosewheel lowered on, the brakes applied and if necessary the H.P. cock set off. The landing run is very much increased.

97. **Wheel brakes emergency operation**

(a) (i) Should the hydraulic system fail, the wheel brake accumulators provide sufficient pressure for brake operation during landing, down to a gauge reading of 750 lb./sq. in. approximately. To conserve pressure when landing without main hydraulic pressure do not operate the lever during the down-wind checks.

(ii) Apply brake pressure in such a way that maxaretting does not occur (little pressure at high speed but increasing with decrease in speed) and avoid differential braking as much as possible. The brake lever should not be released after brakes have once been applied as this will result in a large loss of fluid.

(b) The H.P. cock should be put OFF on touch-down, if the brakes accumulator pressure is low and the runway short.

(c) Check the accumulator pressure after landing. If it is almost exhausted i.e. nearly down to 750 lb./sq. in. the aircraft must not be taxied.

98. Emergency use of oxygen

(a) *Toxic fumes*

If the cockpit becomes contaminated with toxic fumes, set the air-dilution switch on the regulator to 100% OXYGEN and deflect the EMERGENCY switch to either side, to prevent inward leaks on the mask.

(b) *Blinker failure*

(i) If the blinker mechanism ceases to operate check that the main tube is correctly connected, that the pressure on the regulator gauge is normal and that the main oxygen contents gauge is indicating that oxygen is still available.

(ii) If the above indications are satisfactory depress the regulator EMERGENCY switch when in the central position. A supply of oxygen under increased pressure indicates that the regulator is serviceable but that the blinker mechanism is defective. If the regulator is unserviceable, as indicated by no flow, use the emergency bottle and descend immediately to a safe altitude and check all oxygen tube connections.

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(c) *Use of emergency bottle*

(i) If it is necessary to use the emergency oxygen bottle through failure of the regulator or because of exhaustion of the main supply, pull up the emergency control on the right of the seat, and disconnect the mask tube from the main supply point.

(ii) The main supply tube is automatically released and the emergency bottle brought into use on ejection.

(iii) The duration of supply from the emergency bottle is 10 minutes only.

99. Hood jettisoning

(a) The hood is jettisoned by pulling the handle on the port shelf. When Mod. 281 is embodied the force required is greater and it is recommended that a firm sharp pull is used. Mod. 723 reduces the friction loads when the handle is pulled.

(b) To ensure a clean jettison the hood should be closed and the speed should be in excess of 140 knots. The aircraft may be flown at speeds up to 450 knots with the hood jettisoned, but above this speed suction on the pilot's helmet may be disconcerting.

(c) When Mod. 281 is embodied the hood is also jettisoned when either the ejection seat blind or the seat pan alternative handle is pulled, but the G.G.S. is not automatically lowered.

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100. Abandoning the aircraft

(a) Reduce speed as much as possible, set parachute container fully back, and lower the seat fully.

(b) Jettison the hood and retract the GGS. If electrical power is available, the GGS should automatically lower on jettisoning the hood.

(c) Place the feet in the footrests (if fitted) at the same time grasping the firing handle. The elbows must be drawn in close to the body and both hands must grasp the handle firmly, the backs of the hands facing forward.

(d) (i) Draw the handle and face screen firmly over the face, keeping the head pressed hard against the headrest. It is not necessary to jerk the handle and in no circumstances should the blind be pulled outwards away from the face, as it may not then be possible to fire the cartridge.

(ii) When the secondary firing handle is fitted, if conditions of positive G prohibit the use of the primary firing handle, ejection should be initiated by pulling the secondary handle upwards. In this event no protection is given to the face. It is essential that the head is pressed firmly against the headrest to avoid dislocation of the neck on ejection.

(e) After ejection, the drogue gun will fire automatically.

(f) If ejection takes place above 10,000 ft. automatic separation will not occur until that height is reached. If ejection takes place at or below 10,000 ft. automatic separation will occur within 3 seconds.

(g) If the automatic system fails after ejection:—

(i) When forward speed is sufficiently low, discard the face screen and disconnect the main oxygen tube from the seat.

(ii) Pull the override D-ring to isolate the parachute auto device.

(iii) Operate the harness quick release.

(iv) Disengage the seat restraining straps.

(v) Lift the flap over the rip-cord D-ring and grasp the handle.

(vi) Push clear of the seat and pull the rip-cord handle.

(h) The recommended minimum heights for safe ejection, in straight and level flight (minimum airspeed 120 knots) are:—

With 60 ft./sec. gun	200 ft.
With 80 ft./sec. gun	100 ft.

101. Ditching

(a) Model tests of a clean aircraft indicate that a ditching in any but ideal conditions would be very hazardous.

(b) It is recommended, therefore, that except in calm sea and air conditions combined with good visibility, the pilot should abandon the aircraft rather than attempt a ditching.

(c) If ditching is inevitable:—

(i) Jettison the hood, select 100 per cent. oxygen and deflect the emergency toggle sideways.

(ii) Lower full flap and make the approach at the lowest forward speed and rate of descent compatible with good control.

(iii) Ditch along the swell, or, if the swell is not steep, into wind.

NOTE.—The airbrake must be retracted.

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101A. Jettisoning drop tanks

Jettison of the drop tanks, if necessary, must be carried out in straight and level flight, without yaw or side slip, in the following speed ranges:—

(a) Drop tanks without fins	250–300 knots
(b) Drop tanks with fins	200–450 knots

PART V
OPERATING DATA

102. Loading and C.G. data

(a) *C.G. limits*

(i) The C.G. limits, undercarriage down, are as follows:—

Forward limit	0.3″ aft of datum.
Aft limit	12.5″ aft of datum.

(ii) Ballast must be carried if the radar head and ranging unit are not fitted.

(iii) The aircraft is at a forward C.G. loading when fully loaded with internal fuel and ammunition.

(b) *Effects of consumption of expendable stores*

(i) *Ammunition.* Firing ammunition causes the C.G. to move aft (about 1″ per 100 rounds).

(ii) *Fuel*

Consumption of fuel from the wing tanks causes the C.G. to move slightly aft.

Consumption of fuel from the centre tanks causes the C.G. to move slightly forward. Consumption of fuel from the front tanks causes the C.G. to move progressively aft (about 2½″ per 100 gallons).

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(c) *Typical service loads*

Condition	Approx. all-up Weight (lb.)
Clean, full fuel and ammo.	17,140
With two full drop tanks	19,290
With two 1,000 lb. bombs	19,290
Clean, with 1,600 lb. fuel remaining, full ammunition	15,600

NOTE.—Full ammo.=676 lb.

103. Pressure error correction

(a) The ASI sea-level pressure error, over the speed range of the aircraft, is negligible.

(b) The following are the Machmeter pressure error corrections for all heights.

I.M.N.	0·90	0·95	0·98	1·00	1·05	1·10 and above
Correction	0	−0·01	0	+0·02	+0·05	+0·07

104. **Fuel consumptions**

The approximate fuel consumptions, in lb./minute, at various r.p.m/altitude combinations are given below.

R.p.m.	Altitude					
	Sea level	10,000′	20,000′	30,000′	40,000′	45,000′
7,000	48	40	33	26	20	16
7,250	59	48	40	31	24	20
7,500	72	59	48	36	28	24
7,750	90	75	56	40	31	25
8,000	110	85	60	43	33	26
8,600	145	95	65	47	35	27
At best range speed— clean	47 (370K)	34 (300K)	28 (280K)	23 (0.7 M)	21 (0.75M)	21 (0.8 M)
At best range speed— tanks	48 (330K)	37 (305K)	32 (290K)	29 (0·75M)	27 (0·83M)	—
At endurance speed(180-200K)	35	30	25	20	20	20

105. **Take-off distances (clean aircraft)**

The approximate take-off distances, in yards, for various wind and temperature conditions are given below.

Temperature °C.		−15	0	+15	+30	+45
Zero Wind	Ground run	480	600	720	850	1,050
	To clear 50 feet	975	1,160	1,380	1,630	1,900
30 knot Wind	Ground run	280	350	430	500	600
	To clear 50 feet	660	780	920	1,100	1,300

For every 1,000 ft. the aerodrome altitude is above sea level increase the above distances by:—

10 per cent. for ground run.

8 per cent. to clear 50 ft.

106. **Snake climbs**

For tactical snake climbs use the recommended climbing speeds and 8,400 r.p.m.

107. **Endurance**

The speed for maximum endurance varies from 180 knots at low weights to 200 knots at high weights. Para. 104 gives the appropriate fuel consumption figures.

108. **Flight planning data**

(a) *ANM/100 lb. curves*

The family of curves on page 112 shows the approximate ANM/100 lb. for various altitudes, true mach numbers, and r.p.m. settings. The horizontal curves are the ANM/100 lb. curves for the altitudes shown; the vertical dotted curves are the approximate r.p.m. settings required to achieve various true mach numbers. For heights other than those given interpolation is possible.

(b) *Flight planning data tables*

The tables preceding the ANM/100 lb. curves are based on the curves and show the flight planning data for:—

(i) *Climbing*

The climb tables give the data for climbs in I.S.A. conditions using the speeds recommended in para. 66.

(ii) *Cruising*

Each separate altitude block in the cruise tables shows:—

(1) The speed for maximum range, the approximate A.N.M.P.G. and the approximate fuel consumption for the particular height. In addition a speed band is given, use of any speed within which should not cause more than a 5% reduction in range. The height for max. range (clean) is 45,000 ft. Above this height no further range increase is possible.

(2) The range obtainable for various amounts of available fuel when flying at the best range speed for the height. The range given is to the point of let-down, allowance being made for the descent fuel required.

(3) The range obtainable for various amounts of available fuel, including the distance covered on the climb, if a climb is made to another altitude. In this case the climb must be made at the speed given in para. 66 and the flight continued at the new altitude at the best range speed for that height.

NOTE.—The range at any altitude is independent of temperature, but dependent on the weight of fuel carried.

(iii) *Descent*
The descent table gives the data for descending from one height to another.

(c) *Use of the tables*

(i) *Pre-flight planning*

Enter the cruise data table in the sea level block at the fuel state applying immediately after take-off. Select the height at which maximum range is available at that fuel state. The distance available includes distance covered on the climb, but not on the descent. (Absolute maximum range is obtained by adding on the descent distance, provided that the let-down is commenced at that distance from the destination.)
For short-range flights inspect the sea level block and select the height at which the distance to be covered requires the least amount of fuel. This is the best altitude for the flight.

(ii) *In-flight planning*

At any stage of a flight the available range may be ascertained by applying the fuel state to the level flight range in the particular altitude block.

If an increase in range is required, or if a climb has to be made, the new available range may be obtained by entering the existing altitude block at the particular fuel state and moving vertically downwards within the block until the new altitude is reached. Figures in heavy type indicate the best altitude for the maximum increase in range. Above these heights no further range increase is possible. If a descent is necessitated, the new range is shown by moving direct from the existing altitude level flight range for the particular fuel state to the new altitude level flight range.

CLEAN AIRCRAFT

FUEL CONTENTS 388 gallons
2,985 lb. NORMAL AVTAG (7.7 lb./gall.)
TAXY AND TAKE-OFF ALLOWANCE = 270 lb.
LANDING ALLOWANCE
(excluding descent fuel) = 460 lb.

CLIMB DATA

From	To	Lb.	Dist.	Mins.
Sea Level* (430K)	10,000′	390	10	2
	20,000′	510	20	3½
	30,000′	640	35	5¼
	40,000′	790	55	7¾
	45,000′	910	80	10
10,000′ (430K/0.87M)	20,000′	120	10	1½
	30,000′	250	25	3¼
	40,000′	400	45	5¾
	45,000′	520	70	8
20,000′ (0.87M)	30,000′	130	15	1¾
	40,000′	280	35	4¼
	45,000′	400	60	6½
30,000′ (0.87M)	40,000′	150	20	2½
	45,000′	270	45	4¾
40,000′ (0.87M)	45,000′	120	25	2¼

*In this block, fuel used is from start-up; times are from wheels rolling.
CLIMB AS RECOMMENDED IN PARA 66.

DESCENT DATA

From	To	Lb.	Dist.	Mins.
45,000′	30,000′	30	15	2
	20,000′	60	20	3
	10,000′	105	25	4¼
	Sea Level	185	35	6
30,000′	20,000′	30	5	1
	10,000′	75	10	2¼
	Sea Level	150	20	4
20,000′	10,000′	45	5	1¼
	Sea Level	120	15	3
10,000′	Sea Level	75	10	1¾

AIRBRAKE ... ... OUT, FLAP 20°
R.P.M. 7,000
SPEED ... ... 280K.

CRUISE DATA — CLEAN AIRCRAFT

FUEL AVAILABLE Pounds		2,750	2,500	2,000	1,500	1,000
Sea Level	Range	280	250	185	125	60
ANM/100lb —12.5 Lb/hr —2800	10,000′	355	315	230	145	**60**
	20,000′	450	395	280	165	50
Best Range Speed —370K	30,000′	530	460	325	180	35
95% RangeSpeed—260-410K	40,000′	585	500	330	160	—
	45,000′	**605**	**515**	**335**	**155**	—
10,000 ft.	Range	—	330	245	160	75
ANM/100lb —17 Lb/hr —2050	20,000′	—	415	300	185	**70**
	30,000′	—	490	345	200	55
Best Range Speed—300K	40,000′	—	545	375	**205**	—
95%RangeSpeed—240-370K	45,000′	—	**550**	**370**	190	—
20,000 ft.	Range	—	430	315	200	**85**
ANM/100lb —22·5 Lb/hr —1650	30,000′	—	510	365	220	75
	40,000′	—	565	395	**225**	55
Best Range Speed—280K	45,000′	—	**570**	**390**	210	—
95% Range Speed—200K-0.7M						
30,000 ft.	Range	—	—	390	245	**100**
ANM/100lb —29 Lb/hr —1400	40,000′	—	—	425	**255**	85
Best Range Speed—0.7M	45,000′	—	—	**420**	240	60
95% Range Speed—180K-0.8M						
40,000 ft.	Range	—	—	450	**280**	**110**
ANM/100lb —34 Lb/hr —1250						
Best Range Speed—0.75M	45,000′	—	—	**445**	265	85
95% Range Speed —180K-0.86M						
45,000 ft.	Range	—	—	**490**	**310**	**130**
ANM/100lb. —36 Lb/hr —1280						
Best Range Speed —0.8M						
95% Range Speed—180K-0.86M						
FUEL AVAILABLE Pounds		2,750	2,500	2,000	1,500	1,000

NOTE:—These figures are based on flight tests.

WITH DROP TANKS

FUEL CONTENTS:— 588 GALLONS
4,525 lb. NORMAL AVTAG (7.7 lb.gall.)

TAXY AND TAKE-OFF ALLOWANCE = 270 lb.

LANDING ALLOWANCE (excluding descent fuel) = 460 lb.

CLIMB DATA

From	To	Lb.	Dist.	Mins.
Sea Level* (430K)	10,000′	430	10	2¼
	20,000′	590	25	4
	30,000′	770	45	6¼
	40,000′	990	75	10
10,000′ (430K/0.87M)	20,000′	160	15	1¾
	30,000′	340	35	4
	40,000′	560	65	7¾
20,000′ (0.87M)	30,000′	180	20	2¼
	40,000′	400	50	6
30,000′ (0.87M)	40,000′	220	30	3¾

* In this block times are from wheels rolling; fuel used includes taxy and take-off allowance.

Climb at full throttle (See para 66)

DESCENT DATA

From	To	Lb.	Dist.	Mins.
40,000′	30,000′	15	10	1
	20,000′	45	15	2
	10,000′	90	20	3¼
	Sea Level	165	30	5
30,000′	20,000′	30	5	1
	10,000′	75	10	2¼
	Sea Level	150	20	4
20,000′	10,000′	45	5	1¼
	Sea Level	120	15	3
10,000′	Sea Level	75	10	1¾

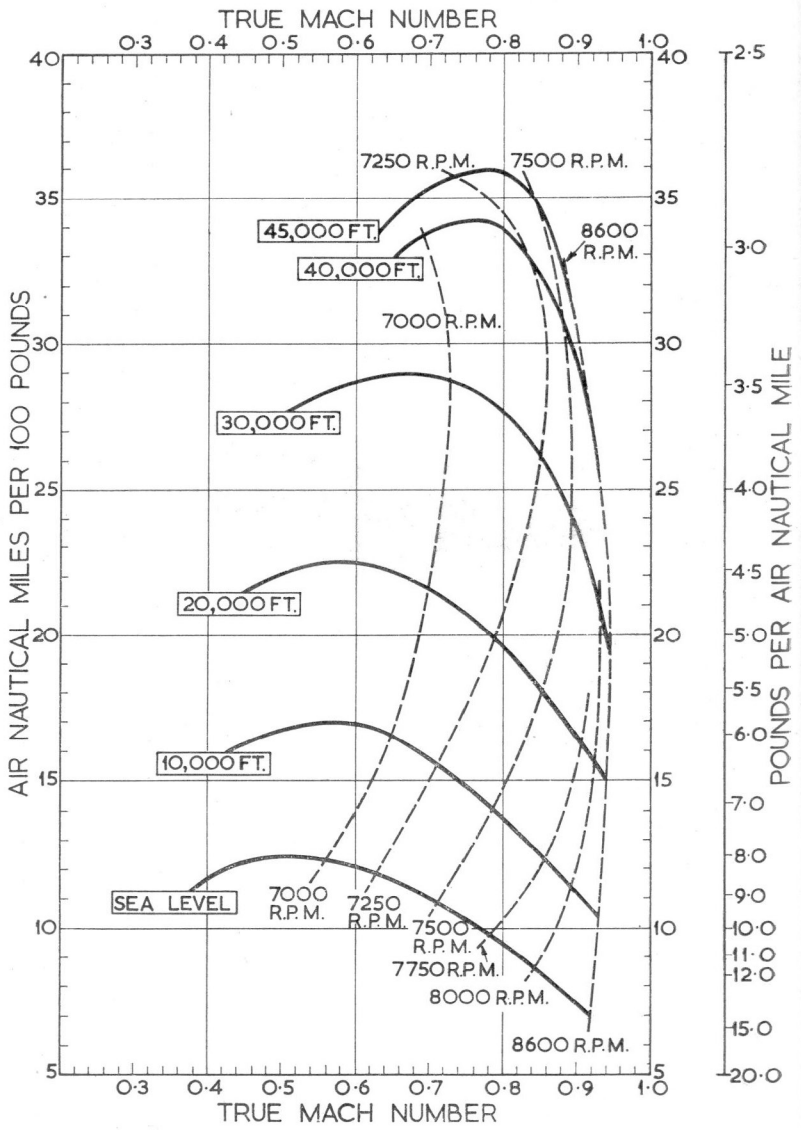
AIRBRAKES - OUT, FLAP 20°
R.P.M. - 7,000
SPEED - 280K

CRUISE DATA—WITH DROP TANKS

Fuel Available—LB.		4250	3500	3000	2500	2000	1500	1000
Sea Level	Range	425	340	290	230	175	115	**60**
ANM/100 lb.—11.5	10,000′	550	440	360	285	205	130	50
Lb./hr. —2900	20,000′	680	535	440	340	240	**140**	35
IAS—330K	30,000′	**810**	630	510	385	**260**	135	—
	40,000′	**905**	**700**	**555**	**410**	**260**	110	—
10,000 ft.	Range	—	450	375	300	220	145	**65**
ANM/100 lb—15.5	20,000′	—	560	465	365	265	**165**	60
Lb./hr —2250	30,000′	—	655	535	415	295	**165**	40
IAS—305K	40,000′	—	**735**	**590**	**450**	**300**	150	—
20,000 ft.								
ANM/100 lb.—20	Range	—	575	480	380	280	180	**80**
Lb./hr. —1950	30,000′	—	670	560	440	315	**190**	65
IAS—290K	40,000′	—	**760**	**625**	**480**	**335**	185	—
30,000 ft.								
ANM/100 lb.—24.5								
Lb./hr. —1750	Range	—	705	585	465	340	**215**	**90**
Speed–0.75M	40,000′	—	**790**	**650**	**510**	**365**	**215**	65
40,000 ft.								
ANM/100 lb.—28.5	Range	—	**820**	**685**	**545**	**400**	**255**	**100**
Lb./hr. —1650								
Speed–0.83M								
Fuel Available—LB.		4250	3500	3000	2500	2000	1500	1000

These figures are based on flight tests.

CLEAN AIRCRAFT



PART VI

ILLUSTRATIONS

KEY TO FIGS. 1, 2 & 3.

1. Cockpit temperature selector.
2. Cockpit temperature control.
3. Cockpit pressure master switch.
4. Flood flow control switch.
5. Cockpit pressure warning test switch.
6. Tailplane motor circuit breaker.
7. Hood motor circuit breaker.
8. Radar test switch.
9. Undercarriage emergency air pressure gauge.
10. Flaps emergency air pressure gauge.
11. Brakes accumulator pressure gauge.
12. Crowbar.
13. L.P. cock control.
14. Airbrake test switch.
15. Hood rail locking indicator (one of four).
16. V.H.F. controllers.
17. V.H.F. changeover switch.
18. Throttle friction control.
19. Press-to-transmit switch.
20. Airbrake control switch.
21. ARI. 18044 switches.
22. Hood motor control and clutch release.
23. Telebriefing switch and warning light.
24. Radar ranging target reject switch.
25. Undercarriage emergency lowering control.
26. Selector dimmer control.
27. Radar ranging on/off switch and supply indicator.
28. Tailplane standby motor control.
29. *Not applicable to Mk. 5 aircraft.*
30. Aileron and rudder trim indicator.
31. Aileron and rudder trim control and locking device.
32. H.P. cock control.
33. Relighting pushbutton.
34. Hood jettison handle.
35. Triple pressure gauge.
36. Undercarriage warning light.
37. Undercarriage position indicator.
38. Airbrake position indicator.
39. Undercarriage selector pushbuttons.
40. Flaps selector and position indicator.
41. Flaps emergency selector.
42. Powered controls indicators.
43. Powered controls selectors.
44. Accelerometer.
45. Tailplane trim indicator.

46. G.G.S. emergency lowering control.
47. Artificial horizon fast erection button.
48. G.G.S. master switch.
49. Radar ranging indicator light.
50. E.2 compass.
51. Windscreen de-icing switch.
52. Fire warning light and extinguisher button
53. DME indicator.
54. ARI 18044 indicator.
55. Cockpit altimeter.
56. Cockpit pressure warning light.
57. Oxygen contents gauge.
58. Camera aperture switch.
59. Audio warning cut-out switch.
60. Tailplane trim control switch.
61. Generator failure warning lights.
62. Starter pushbutton.
63. Starter master switch.
64. Pressure-head heater switch.
65. G45 camera switch.
66. Ignition switch.
67. Battery master switch.
68. Rudder pedals adjusting control.
69. Emergency oxygen control.
70. Navigation lights switch.
71. Fuel transfer warning indicators.
72. Fuel contents check switch.
73. Fuel contents (lb.) gauges.
74. Oxygen regulator.
75. Wing tanks empty warning indicators.
76. Emergency lamp switch.
77. Cockpit lighting switches.
78. Booster-pumps switches.
79. IFF switches.
80. Anti-G control.
81. Anti-G test button.
82. Anti-G pressure gauge.
83. Booster-pumps ammeter socket.
84. Booster-pumps circuit-breakers.
85. Starter circuit-breaker.
86. Mk. 4F compass test panel.
87. Booster-pumps test switch.
88. Butt test switch.
89. DME control panel.

NOTE.—The following items are not keyed:—
Pylon stores control panel (aft of 16). *Not illustrated.*
Hydraulic pressure warning light (above 39).



FIG 1

COCKPIT—PORT SIDE

FIG 1

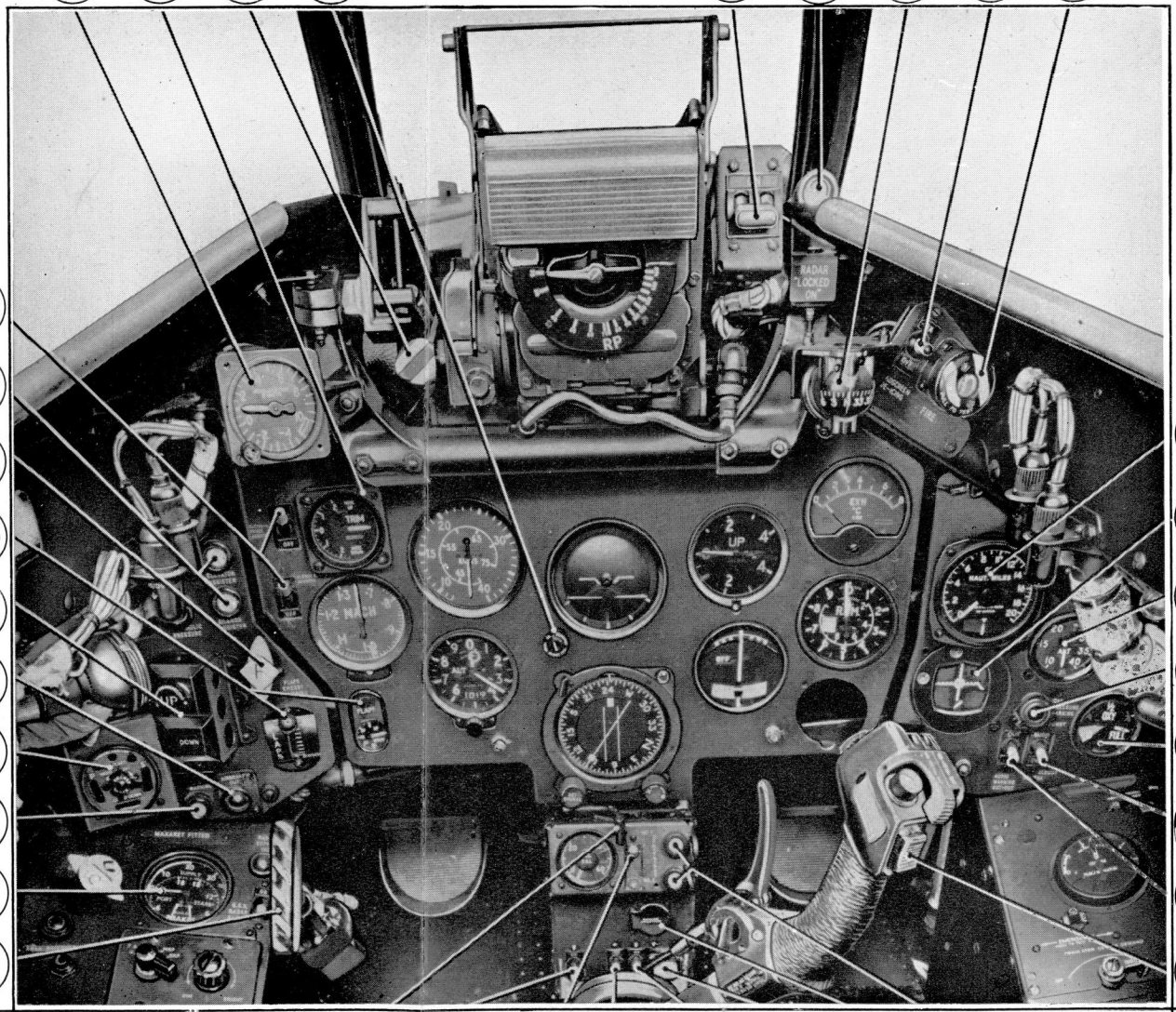


FIG 2

COCKPIT - FORWARD VIEW

FIG 2

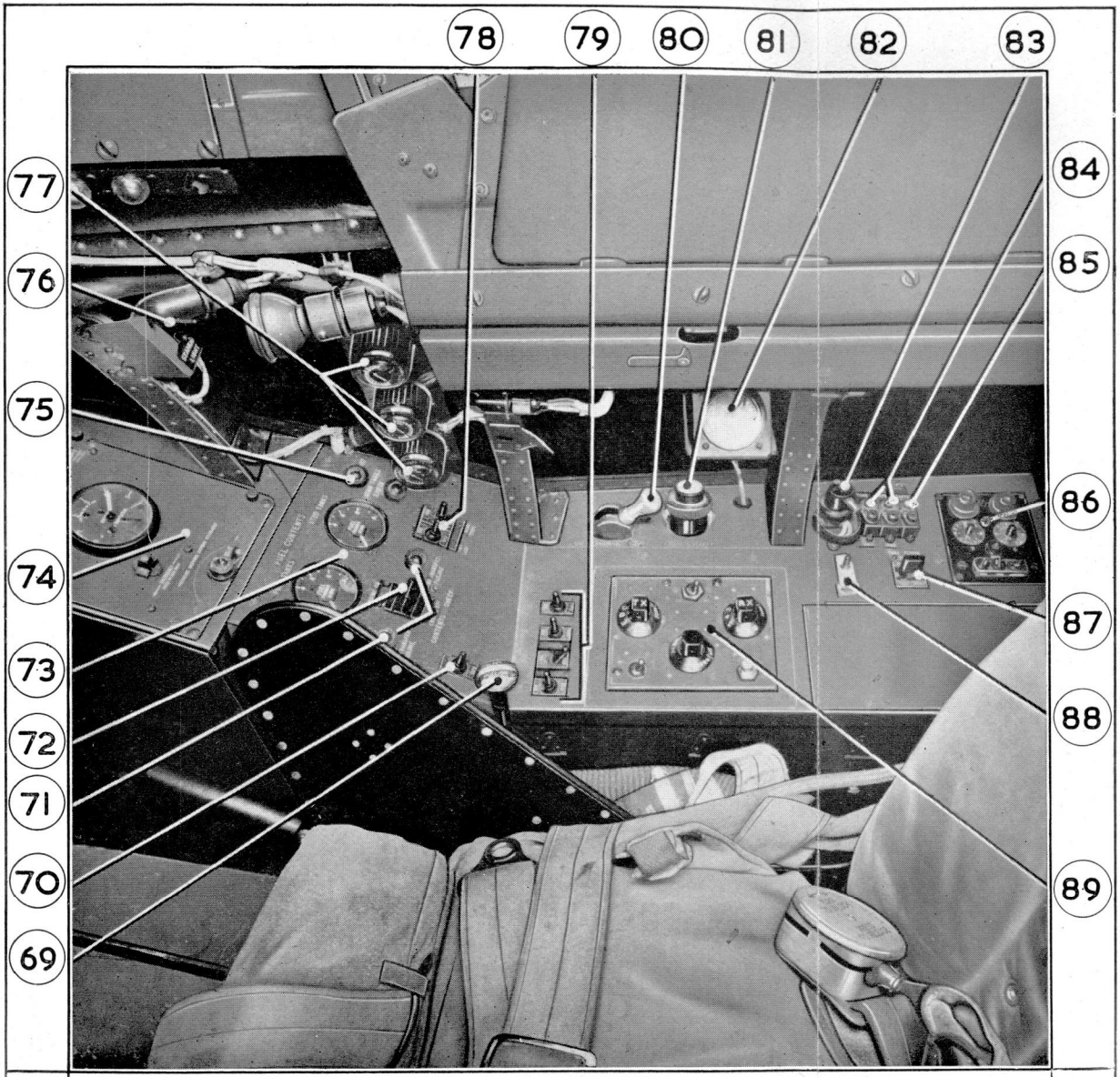


FIG 3

COCKPIT – STARBOARD SIDE

FIG 3

REMINDER

IF IT IS NOT POSSIBLE TO CLEAR A STICK JAM IN FLIGHT, SELECT POWER OFF IMMEDIATELY

EMERGENCY DRILLS

MANUAL REVERSION

Max. speed	250K or 0.80M
Tailplane trim	Zero stick force
Aileron trim	Neutral
Trim guard	Release
Selectors	Power OFF, elevator followed by aileron

ACTION IN THE EVENT OF FIRE

1. Close throttle immediately.
2. If light stays on

L.P. and H.P. cocks	OFF
Booster pumps	OFF
Airspeed	Minimum

3. Press extinguisher button.
4. If fire goes out, light goes out.
5. Do not relight.
6. Carry out forced landing.

IF FIRE PERSISTS—ABANDON.

ELECTRICS FAILURE

1. If one generator fails, keep r.p.m. above 4,000 and avoid use of non-essential electrics.
2. If both generators fail, batteries last 9 mins. max. without radar. After that no electrical selection.
3. Action:—
   Switch off all non-essential electrics.
   Set tailplane to zero.
   Reduce height if necessary.
   If hydraulics O.K., leave flying controls in Power.
   If hydraulics suspect, select Manual before batteries exhausted.
   Lower u/c and flaps on emergencies.

HYDRAULICS FAILURE

1. Complete failure

Flying controls	Select Manual: (1) If auto-reversion occurs or (2) Before joining circuit
U/c and Flaps	Lower on emergencies
Wheel brakes	Limited use only

2. Partial failure
   As above, but select Manual if electrical failure is likely. If electrics *have* failed *before* partial hydraulic failure, prepare to abandon.

ENGINE FAILURE

1. Seizure
   Close throttle. Turn off L.P. and H.P. cocks, switch off booster pumps.
   Switch off non-essential electrics.
   Set tailplane to zero.
   Carry out forced landing, or abandon.
2. Flame out
   Close throttle, turn off H.P. cock.
   Leave L.P. cock on.
   Booster pumps off.
   Non-essential electrics off.

RELIGHTING

Height	Below 35,000 ft.
Max. speed	200 knots above 25,000 ft. 0.8M below 25,000 ft.
Battery master	ON
Engine master	ON
Ignition	ON
Booster pumps	ON

Press relight button (30 secs. max.) and open H.P. cock simultaneously. Release button when r.p.m. rise to idling.

FAILURE TO RELIGHT

Turn off H.P. and L.P. cocks.
Switch off all electrics (incl. booster pumps).
Set tailplane to zero.
Carry out forced landing, or abandon.

FORCED LANDING

Best gliding speed	210 knots
Airbrake	IN
H.P. and L.P. cocks	OFF
Booster pumps	OFF
Tailplane	Zero
All non-essential electrics	OFF
Power controls:	Select Manual: (1) Before electrics fail or (2) If auto-reversion occurs or (3) Before joining circuit

Plan a Manual approach. Overhead at 6,000-7,000 ft., downwind at 4,000 ft. Airspeed 175 knots. When certain of reaching touchdown point select full flap.
Cross threshold at 150 knots.

EMERGENCY DRILLS (Cont.)

UNDERCARRIAGE AND FLAPS EMERGENCY

1. Hydraulic dumping if electric and hydraulic power available.
2. Once either service lowered on emergencies cannot be raised again.
3. Flaps lower fully down only.
4. Undercarriage UP on ground only after normal down selection.

ABANDONING

1. Jettison hood above 140K. Retract GGS.
2. Feet in foot rests, head back on rest.
3. Pull blind handle.
4. Auto separation at or below 10,000 ft.
5. If auto-separation fails, operate override D-ring and seat harness release. Raise flap and grasp ripcord D-ring. Push clear of seat and pull D-ring.

CHECK LISTS

FINAL CHECKS FOR TAKE-OFF

Trim	Tailplane neutral (1° n.u. with drop tanks).
	Rudder and ailerons neutral, trim lock engaged. Spring feel neutral.
Fuel	Booster pumps ON or AUTO (MANL with drop tanks).
	Warning lights (when fitted) out.
	Fuel press indicator black.
	H.P. cock ON and locked.
	L.P. cock ON. Transfer indicators black.
	Contents.
Flaps	Up (38° with drop tanks).
Instruments	Check and set.
	Pressure head heater ON.
Oxygen	100% OXYGEN.
	Emergency switch central. Blinker operating.
Hood	SHUT (Not OFF).
	Clutch LOCKED.
	Cockpit pressure ON (OFF in conditions of high humidity).
Harness	Tight and locked.
Hydraulics	Pressure 3,000 lb./sq. in.
	Flying controls in Power
	At 4,500 r.p.m. apply full aileron and elevator and ensure that the magnetic indicators remain black. Warning light out.

FINAL CHECKS FOR LANDING

Speed below 230K.	
Airbrake	In. Indicator black.
Undercarriage	Down. Three greens.
Brakes	Main supply 2,000 ± 150 lb./sq. in. 1,500 lb./sq. in. at each wheel.
Flaps	As required. Fully down on final.
Fuel	Contents.
	Both booster pumps ON or AUTO.
Harness	Tight and locked.

THRESHOLD SPEEDS

At max. weight	135K
At light weight	130K

INSTRUMENT APPROACH

	Speed	Flap	R.p.m.
DOWNWIND	170/180	40°	7,000
BASE LEG	170/180	40°	7,000
GLIDE PATH	150/160	Full	7,000

ENGINE LIMITATIONS

Take-off (15 mins.)	8,600 ± 50 660° C.
Intermediate (30 mins.)	8,400 620° C.
Max. continuous	8,200 580° C.
Min. approach	5,000
Ground idling	3,000 + 200 — 0 570° C.